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REFRACTORIES IN METALLURGICAL INDUSTRIES*

By John D. Sullivan

Abstract

Refractory performance, requirements, and life in the major metallurgical industries are discussed and the effect of improvements of refractories on metallurgical products and the life of furnaces are outlined. Newer refractory products are discussed and the place they are finding in the metallurgical industries mentioned.

I. Introduction

The metallurgical industry is dependent on the ceramic industry for materials of construction. The ceramic industry likewise depends on the metallurgical industries as the chief outlet for refractories. In this country they consume more than one-half of the total production. According to a study made in 1923,[1] open-hearth furnaces take more than one-third of the refractory brick, blast furnaces and heating furnaces about 7% each, cupola and smelting furnaces between 3 and 4% each, and malleable iron plants over 2%.

Tyler[2] estimates the current distribution of refractory sales in dollars to be as follows:

Industry	Total sales (%)
Iron and steel	50
Public utilities	20
Nonferrous metals	6
Cement and lime	5
Glass	5
Oil refining	4
Ceramic miscellaneous	3
Miscellaneous	7

The past decade has seen vast improvements in metallurgical practices, but newer and better refractories in most cases can claim part of the credit. It will not be possible in a brief paper to review all the refractory advances and their effect on the metallurgical industries. The aim of this paper is to give a general summary of the refractory requirements and life in the metallurgical industries consuming the most refractories and to show the effect of refractory developments on performance and life of furnaces.

II. Basic Open-Hearth Furnaces

Basic open-hearth furnaces are the greatest users of refractories and they present a variety of refractory problems with rigid requirements. Because of the high temperatures employed, the corrosive basic slag, and method of heating, conditions are severe on refractories. Buell[3] states that there are fewer than 1000 basic open-hearth furnaces in the United States classified as follows:

Up to 49 tons capacity	103
50–79	276
80–109	383
110–149	82
150–199	59
200 or more	11
Tilting	32

To appreciate fully the refractory requirements in an open-hearth furnace, the chemical nature of the basic slag should be borne in mind. Typical slags analyze as follows:

Ingredient	(%)	Ingredient	(%)
CaO	40–42	Al_2O_3	4–1
MgO	10–8	P_2O_5	5–1
FeO	15–35	SiO_2	20–10
MnO	6–3		

(1) Bottoms

Open-hearth bottoms usually consist of metal plates lined with fireclay brick, followed by basic or neutral brick, and finally on top of this a sintered layer of dead-burned magnesite mixed with 10 to 25% of open-hearth slag. Up to about 10 years ago magnesite brick were used almost exclusively for furnace bottoms. Today, because of cost, magnesite brick are being replaced in bottoms by chrome brick. In some plants crushed chrome ore covers the chrome brick and a thinner layer of magnesite and slag is employed in the hearth. It is general practice, however, to use magnesite brick around the tap hole, and a few companies use all-magnesite bottoms. In the last few years, many plants in constructing new furnaces have inserted an insulating layer between the fireclay brick and the metal shell. A typical open-hearth bottom of today may have a $2\frac{1}{2}$- to 4-inch layer of insulating brick, $4\frac{1}{2}$ to $13\frac{1}{2}$ inches of fireclay brick, 6 to 12 inches of

* Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, March 31, 1936 (Refractories Division). Received March 6, 1936.

[1] "Where Refractory Bricks Go," *Iron Age*, 112, 402 (1923).

[2] P. M. Tyler, personal communication.

[3] Wm. C. Buell, Minutes of 17th Open-Hearth Conference at Pittsburgh, Pa., p. 20 (1934). (Private publication of A. I. M. M. E.)

magnesite or chrome brick, and 12 inches of sintered magnesite plus slag mixture.

Open-hearth bottoms last about 20 years but must be patched after each heat. Deep holes in the hearth are repaired with dead-burned magnesite or prepared refractory burned dolomite. Shallow holes are repaired with raw or calcined dolomite.

Attempts have been made at times to replace the magnesite brick with mixtures of dead-burned magnesite and Portland cement. Prepared dolomites have also been tried in place of the magnesite-slag mixtures. These changes, however, have met with indifferent success. The hearth must withstand shock during charging, be dense enough to prevent soaking up the slag, resistant to attack by slag, and thoroughly sintered to avoid holes by part of the bottom material coming loose. Bottoms more refractory than those now put in would be desirable but are impractical because they would necessitate a sintering temperature higher than the silica roof will withstand.

(2) Roofs

The temperature inside an open-hearth furnace is 2800° to 3000°F. Refractories in the roof and walls must not only be able to withstand this high temperature but also the chemical attack of fumes and corrosive gases, laden with solid particles, and sudden temperature changes. Virtually all furnaces have sprung arches and the refractories must stand considerable pressure without softening, crushing, or distorting. Iron oxide rising from the bath gradually attacks the silica brick in the roof and finally causes dripping. Various kinds of brick have been tried in roofs but none is more satisfactory than silica.

Considerable trial-and-error effort has been made to determine the most economical thickness of roof brick to use. At present the tendency appears to favor the use of 12-inch brick with 15-inch ribs or 15-inch brick with 18-inch ribs. Another favored construction is the use of 15-inch brick in the main section and 18-inch near the skewbacks. With this latter construction, ribs are not always used but are of 21-inch size when used in the portion near the skewbacks. Buell[4] states that for an 18-foot span, 18-inch brick are statically correct and greater spans call for greater thickness.

[4] Wm. C. Buell, Minutes of 16th Annual Open-Hearth Conference held in Chicago, p. 107 (1933). (Private publication of A.I.M.M.E.)

The life of an open-hearth roof is variable and depends on the size of the furnace and service conditions. A few years ago roofs were replaced every 100 to 125 days, which corresponded to 250 to 350 heats for large furnaces and 300 to 400 heats for small ones. The era of insulation resulted in considerably longer refractory life. One operator reported that, prior to insulation, patching of the roof commenced at 275 to 300 heats, at which time patching 1 to 4 feet out from the skewbacks was required. At that time about 425 heats represented a furnace campaign. After insulation, very little patching was done up to 350 heats, and the furnace campaign was increased to 470 heats. In the Chicago district at a certain plant the average life of a 120-ton furnace roof before insulation was about 350 heats. After insulation, as high as 566 heats on one campaign were obtained. Recently this plant shut down a furnace after 502 heats and found that the main section of the roof had lost only about 2 inches of thickness. This section is to be used on another campaign and the operators are hopeful that this furnace will run 1000 heats. While the above example is rather unusual, furnace operators generally report an increase of 10 to 25% in roof life after insulation.

Insulation has proved to be one of the greatest recent advances in improving refractory life of open-hearth roofs. At first, the reason for using insulation was to decrease fuel costs, and this has been accomplished. In many cases increased life can not be entirely credited to insulation because, simultaneous with the introduction of insulation, many furnaces also installed mechanical control of combustion to maintain a balanced draft over the hearth and to prevent overheating periods. Many furnaces, however, installed automatic draft control and flame reversals before insulating, and the insulation was found to increase life. This is reasonable to expect because, with reduction of heat loss through the roof, an equivalent heat transfer to the bath can be maintained with less fuel consumption or with lower flame temperatures. Insulation on the roof also results in a smaller temperature gradient throughout the brick with the result that it is more resistant to thermal spalling.

A few efforts have been made to use suspended silica roofs. One operator reported a short life due to spalling. The general consensus of opinion

appears to be that increased life is not great enough to justify added costs.

(3) Front and Back Walls

Front and back walls, in general, have a shorter life than roofs if the same refractory is used. Deterioration is caused by absorption of iron oxide from the gas stream, the cutting action of the flame, and spalling. The latter is especially bad in the front walls, particularly in door jambs. There is also some chemical attack from slag splashed from the bath and from iron silicate dripping from the roof. Considerable changes have been made in wall design. Most furnaces now employ sloping back walls and many have sloping front walls as well. Increased life and easier application of patching and fettling for protection have resulted.

Front walls generally are constructed with silica brick, but sometimes a facing of ground chrome ore is used. In some cases the bottom four or five courses of sloping walls are made of magnesite and the rest of silica. Patching is ordinarily done with silica. The average life is about 100 to 150 heats with silica brick. Some furnaces use chrome and Kromag brick, unburned chrome, Metalkase magnesite, or burned or unburned magnesite. Basic and neutral brick are reported to give at least twice the life of silica. Ordinarily 13-inch brick are used in front walls.

Back walls were formerly built almost exclusively with silica brick, usually with one course of chrome brick between them and the magnesite brick of the hearth. At the present time chrome and Kromag brick find wide use. Metalkase brick and unburned magnesite and chrome brick are also finding some use. Sloping back walls simplify practice and bottom-making material, such as dead-burned magnesite and prepared, raw, or calcined dolomite, can be thrown upon the wall above the slag line. This protects the wall proper. Patching is usually done with ground chrome or chrome cement. A Quigley gun is sometimes used to apply patching. One operator reports that Kromag gives 25% better life than chrome brick. Back walls today, if constructed of basic or neutral brick, usually last the life of a furnace campaign.

(4) Ports and Bulkheads

Ports and bulkheads or end walls should be considered as a unit. Abrasion is an important factor due to the changing direction of the gas stream which, laden with oxide particles, has a more severe cutting action than on the roof. Formerly, silica brick were used almost exclusively. A coating of fine chrome ore is frequently used with silica end walls, thus giving a surface more resistant to attack of oxides in the furnace gases. Design of ports is probably equally as important as refractories in determining life of ports and end walls. At one time refractory life was definitely shorter with producer gas than with oil firing. This was largely due to use of a longer flame, whereby considerable burning was done in the uptakes at the opposite end. Port design, however, has improved this condition and some operators have reported better life of both front and end walls. One operator reported 40 heats with stationary and over 200 with movable ports. Mechanical control of combustion and improved furnace design have also improved end-wall life, which, however, is still quite variable. Silica brick, which are from 12 to 18 inches, give as low as 40 and rarely more than 125 heats. Many operators employ used silica roof brick in construction of end walls. Chrome brick are now finding some use and many operators report bulkheads lasting from 125 to 300 heats. Ordinary chrome brick do not last the life of the furnace. Metalkase and chemically bonded unfired magnesite brick are quite widely used and bulkhead life of 450 to 500 heats is common. As high as 650 to 700 heats have been reported, and one operator got 897 heats from an 18-inch bulkhead of Metalkase brick. Unburned or chemically bonded chrome brick are also being used.

High-alumina (70%) fire brick have made some excellent records in ports. Where high-alumina brick are used, water-cooling is usually employed. With basic or neutral refractories, ports are not water-cooled.

Forsterite brick, one of the developments of the last two or three years, are finding their widest use in bulkheads. While they have not been used so long as some of the older basic brick, experience has shown that their life is generally in the same order as that of chemically bonded or Metalkase brick.

Uptakes and downtakes are usually built of silica brick.

(5) Checker Chambers

Checker chambers are designed to absorb heat

from the exit gases and to give as much of it as possible back to the air or gases for combustion. Requirements are high thermal capacity, high thermal conductivity, resistance to slagging action of dust, and resistance to spalling by temperature changes. Maximum top checker temperatures vary widely in different furnaces but in general are from 2300° to 2600°F. In so-called cool checkers, dust is often deposited in a loosely sintered condition, and occasionally in very hot chambers the dust reacts with the checker brick to form a slag. Air checkers usually become clogged and must be cleaned out frequently because clogging slows down the production rate, which in turn affects the quality of some steel. Usually one-third to one-half of the upper sections of the checkers are removed in repairing, and the deposit is removed from the lower portion. As much as 70% of removed brick is reclaimed. Silica brick have been used for checkers but fireclay brick are now ordinarily used. Within the past two or three years the tendency has been to use super-duty fireclay brick (cone 33) at least for upper courses. These brick are denser, more refractory, and have less tendency to spall than high-duty fireclay brick. Much better performance is indicated with this type of brick. The dust that accumulates in checkers is largely Fe_3O_4. In air checkers this usually does not flux with the brick and gradually accumulates until it has to be removed. In gas checkers the Fe_3O_4 is reduced to FeO which reacts with the checker brick. The more refractory super-duty fireclay brick apparently are not so readily clogged and are more easily cleaned than less refractory fire clays. Their density also gives them better thermal conductivity and capacity.

The usual life of top-course checkers is about 150 to 300 heats, although one operator reported a life of 738 heats on a 2-pass checker with the first one not burned out at that time.

Magnesite and chrome brick have been tried, but the results have not been satisfactory. Silica brick have also been found inferior to high-grade fire clay.

Insulation to prevent air infiltration and to conserve heat has resulted in increased efficiencies, and mechanical control of combustion has increased checker life.

(6) Tapholes

Tapholes are an important part of the open-hearth furnace. The mixture must give a dense unit that has strong physical properties to hold the metal and at the same time be soft enough to be knocked out easily with a tapping bar. Tapholes are frequently made with a mixture of raw and burned dolomite. A mixture of a chrome-base cement and dead-burned magnesite also finds extensive use.

(7) Ladles for Steel

The lining for ladles used in teeming steel presents one of the most difficult refractory problems in the entire open-hearth industry. From a chemical standpoint it does not appear logical to refine steel in a basic furnace and then tap the steel into an acid-lined container. Inclusions may be picked up from an acid lining. On the other hand, basic linings have not proved satisfactory and fireclay linings are used exclusively. The brick are rather soft to withstand spalling and are not highly refractory. Ladle life is short. The usual life is 8 to 10 heats, although in a few instances lives of 30 to 40 heats have been reported. Lining life can be increased by use of a clay slurry but cleanliness of the steel is endangered. High-carbon steels are easier on ladle refractories than low-carbon types.

Ladle linings must be dense enough to resist penetration and should be resistant to silicates high in lime and iron oxide. The refractory should be resistant to the cutting action of a stream of steel at 2800°F and yet it must not spall. It must not adhere to the skull of the metal and be pulled out when the latter is removed. Tight joints are essential and allowance must be made for thermal expansion. Accuracy and uniformity of brick size are important.

Insulation has been successfully applied to ladles. Usually this takes the form of a layer, 1 to $1^1/_2$ inches thick, between the metal shell and the firebrick lining, which varies from $2^1/_2$ to 9 inches. The use of several rowlock courses above the bottom and in the sections nearest the metal stream has become rather general practice.

Some attempts have been made to use basic lining, but the results have not been very satisfactory. The spalling was bad and the slag had a tendency to stick. Skulls also formed on the bottom of the ladle and in removing them the bottom was damaged and had to be renewed. One operator reported using magnesite as a patching agent but stated that it grew and blistered.

Monolithic linings of crushed ganister bonded with clay have given long life in some steel casting plants employing acid furnaces.

(8) Nozzles

Nozzles require careful attention and should be true to shape and carefully fired. Nozzles must be sufficiently refractory but still soft enough to maintain a proper seat for the stopper. They must be resistant to cutting by the stream of molten steel and should not contaminate the steel. Magnesite stoppers are now available for pouring special steel where the absence of inclusions outweighs added cost. Stoppers are usually made of fire clay and graphite. This is sufficiently refractory and forms a tight seal with the nozzle, which is slightly plastic at teeming temperatures. Sleeve brick are made of fire clay. The composition and texture of sleeves and stoppers must be such that there is no danger of failure of the inner steel rod or stopper pin during teeming of a heat. Freedom from cracks is of paramount importance in sleeve brick.

III. Acid Open-Hearth Furnaces

Acid and basic open-hearth furnaces differ essentially only in hearth composition. Most acid open-hearth furnaces are small and are used for making steel for castings. A 25-ton furnace with a 10-foot roof span and a length of 35 to 40 feet is a common size.

Bottoms are made of silica brick covered with sintered layers of silica sand. The latter should be quite pure. The acid hearth gradually absorbs iron oxide during melting of the charge, and the bottom thus becomes a mass of silica bonded with iron and other silicates which gradually increase in amounts with absorption of more silica until the refractoriness of the bottom is destroyed.

The slag, consisting largely of iron silicate and some manganese silicate and occasionally calcium silicate, attacks the hearth at the slag line. A function of the bottom appears to be that of supplying silica for fluxing iron oxide formed in melting the charge. Repairs are made after each heat with crushed ganister or silica sand.

Acid open-hearth furnaces are not run at such high performance demands as basic ones, and resultant refractory life is considerably longer. The roof life is commonly 1000 to 1500 heats, which constitutes a furnace run or campaign. At the end of that time the entire furnace is rebuilt above the floor line. Back walls ordinarily last the life of the roof if the practice of banking silica sand clear to the skewbacks is followed. The banking is given a thorough repair at least once a week. Front walls ordinarily last the life of the furnace except the jambs which require replacement once during a run. The end walls last a run, although the end panels on either side of the burner have to be replaced about every 200 to 250 heats. Checker brick are generally silica and ordinarily last an entire campaign, at which time the top courses are replaced. At the end of each run checkers are thoroughly cleaned. One difference exists between the basic and acid bottoms, *i.e.*, whereas the former last approximately 20 years, acid bottoms are entirely replaced after each campaign or run. About 10% of the brick are recovered.

Insulation is gaining favor in the acid open-hearth industry and the advantages of fuel savings and better refractory life are reported.

In general, it can be stated that destruction of upper parts of the furnace and clogging of checkers are caused by the same influences discussed under basic open-hearth furnaces (section II). Basic slag in gases and by spattering, however, intensifies attack.

IV. The Bessemer Converter

Only the acid Bessemer process is in use in America. The converter consists of a steel shell supported by two trunnions on which it can rotate. One trunnion is hollow and connects the blast from the blower with the windbox at the bottom of the furnace. The converter can be rotated through an angle of about 270°. The lining of the bottom is pierced with some 250 half-inch holes which connect the windbox with the inside of the furnace and serve as tuyères. The bottom of the converter is fastened to the body so that it can be readily detached and replaced with a new one.

The lining is either a rammed mix principally of silica or ganister held together with a small amount of fire clay, or blocks of ganister, sandstone, or schist. Natural blocks are most widely used. A lining may last 10,000 to 20,000 heats, if minor repairs are made after each heat and more extensive ones about once a week, but a life of about 1000 heats is more common. Converter slags corrode the lining only slowly because they are highly siliceous. Uncombined iron

oxide, however, attacks silica rapidly and the attack around the tuyères is quite vigorous. Bottoms last only 25 to 30 heats. They are built by placing fireclay tuyère brick in position and filling around them with a silica-clay mixture and sometimes coke breeze. There are usually 15 to 30 tuyères and each has 12 to 18 holes approximately $^1/_2$ inch in diameter. Bottom life is shortened[5] by (1) hotter blows, (2) longer blows, (3) lower blast pressure, because the blast holds the metal away from mouths of the tuyères, and (4) more manganese in the pig iron, because the resultant slag is more corrosive.

Although the Bessemer converter is still a factor in the production of steel in America, it is not particularly important to the ceramic industry, because linings are either rammed or made from blocks of sandstone, or the like, and but few fired refractories are employed.

V. Iron-Blast Furnaces

A single iron-blast furnace lasts for several years of continuous service but, owing to the large number of brick required in construction, it ranks high as a consumer of refractories. Depending on size, a blast furnace will require from one-fourth million to nearly one million 9-inch equivalent brick. The lining life varies with the kind of iron made, the character of the charge, and the quality of stock distribution. Lining life is shorter in making ferro alloys than when iron is the product.

The hearth receives molten metal and slag at a temperature of 2500° to 2800°F and at the time of casting holds from 100 to 250 tons of molten metal. This weight plus the blast pressure puts a severe load on the refractories, especially at the bottom.

The temperature of the tuyère zone is 2900° to 3100°F but is considerably lower at the surface of the inwall. The slag is essentially calcium aluminum silicate. A typical analysis follows:

Ingredient	(%)
SiO_2	33
CaO	48
MgO	5
Al_2O_3	12
FeO	1
Others	1

Fireclay brick are used in construction of blast furnaces. Brick containing a high content of flint clay are finding wide application in hearths and boshes. Power-pressing and vacuum methods of fabrication have been introduced to yield a denser and more uniform product. The biggest improvement in blast-furnace brick in the past few years is a harder fired brick. Harder firing is employed to unite all the iron oxide as silicate, and some manufacturers use a reducing atmosphere in part of the firing in an attempt to reduce the iron oxide to FeO, which will unite with silica to form ferrous silicate.

The principal requirements of hearth and bosh are resistance to deformation under high loads at high temperatures and resistance to chemical attack by the slag. Brick should be dense to prevent penetration of slag and molten metal and hard enough to prevent abrasion by the charge, especially at the bosh. Water-cooled iron plates inserted in the wall maintain the brick in the hearth and bosh at a low enough temperature to remain rigid at operating temperatures and to resist the reaction of the slag. Hearth bottoms are built several feet thick, but the brick soften and are gradually replaced by metal which freezes.

Shaft brick ordinarily are not so refractory as those in lower parts of the furnace. Cooling plates are used part way. The brick at the top are heated to only about 400°F. The brick should be hard to resist abrasion, strong enough to stand the shock of introduction of charge, and the iron should be in the form of silicate, because iron oxide and possibly metallic iron catalyze the reduction of carbon monoxide to carbon and carbon dioxide. Carbon deposits build until the brick disintegrates.[6] The maximum reaction rate occurs between 450°C (842°F) and 500°C (932°F).[7]

Zinc contained in the charge also causes swelling and disintegration of the lining. Menke[8] reported that furnace shells are cracked by this action, and he gave analyses of brick taken from several furnaces. Zinc in the form of metal and oxide was

[5] Bradley Stoughton, Metallurgy of Iron and Steel, p. 178. McGraw-Hill Book Co., 4th ed. (1934).

[6] (*a*) C. E. Nesbitt and M. L. Bell, Disintegration of Fire Brick Linings in Iron Blast Furnaces, pp. 216–42. Yearbook, Amer. Iron and Steel Inst., 1923.
(*b*) B. M. O'Harra and W. J. Darby, "The Disintegration of Refractory Brick by Carbon Monoxide," *Jour. Amer. Ceram. Soc.*, **6** [8] 904 (1923).

[7] C. C. Furnas, "Kinetics of Some Reactions of Interest to Ceramists: Mechanism and Rates of Some Heterogeneous Reactions Applicable to Ceramics," *ibid.*, **19** [6] 177–86 (1936).

[8] P. O. Menke, "Lining Failures Caused by Zinc," *Iron Trade Rev.*, **70**, 1409 (1922).

often found with carbon several inches from the inside surface, and from there nearly to the shell the lining disintegrated; more metallic zinc was found near the shell, especially where water-cooled. A probable explanation is that zinc vapor, formed in the hotter part of the furnace with furnace gases, penetrates the lining until the temperature drops to the point at which zinc condenses. At this lower temperature gases that were reducing to zinc at higher temperatures become oxidizing and some zinc oxide is formed.

Alkalis vaporized in the lower sections of a furnace sometimes condense in the colder parts above and decrease lining life. Booze[9] reported as much as 25% of these oxides in a brick taken from a furnace.

Improved refractory manufacture and use of cleaner gases and higher temperatures in stoves have improved blast-furnace practice and lengthened refractory life. Formerly 1,000,000 tons of iron were considered to be good refractory life for a blast furnace, but today a life of 1,500,000 tons is expected and 2,000,000 has been attained.

VI. Heating Furnaces

In this group are included soaking pits, billet and bar, reheating, annealing, normalizing, and forging furnaces. In soaking pits, the temperature is about 2200° to 2400°F, and iron oxide is formed by oxidation of the surface of the ingots. Refractory requirements are probably more severe than in other types of heating furnaces. Magnesite is more resistant to slagging but more susceptible to spalling action. Usually soaking pits are constructed of fireclay brick and sometimes of silica brick or silica firestone, but frequently the bottom courses are magnesite. Unburned and low iron magnesite brick have given better service owing to better resistance to spalling. The bottoms are usually filled with coke.

Annealing, normalizing, and similar furnaces do not present a severe refractory problem because they ordinarily operate at low temperatures. Since a range of 1200° to 1800°F covers most furnaces of this type, highly refractory materials are not required. Resistance to abrasion at the bottom and to spalling in the roof and walls is required. Formerly these furnaces were made almost exclusively of fireclay brick. Today many such furnaces, except for the bottom, are built entirely of lightweight brick. The chief characteristic of lightweight brick that makes them particularly advantageous for heating furnaces is that they have low heat capacity. After weekend shutdowns they can be brought to operating temperatures in a shorter time and with less consumption of fuel than those constructed of dense brick. Lightweight brick may be used advantageously where heat loss by storage is greater than that by conduction. The resistance to spalling of lightweight brick is not so good as that of dense brick made of the same materials.

Fireclay refractories are widely used in reheating furnaces. Resistance to spalling is required in roofs and walls. Bottom refractories must resist the abrasive action of billets and the fluxing action of scale. Bottoms are constructed of fireclay or silica brick or plastics, usually of a chrome base. In some instances silicon-carbide or corundum bottoms have been used.

Forging furnaces are usually constructed with fireclay roofs and walls. Bottoms are of fireclay brick or plastics. Refractory failures are due to spalling and abrasion. A few forging furnaces have been constructed of lightweight brick, but most manufacturers do not recommend their product for this use.

VII. Iron Cupola

Cupola brick must resist high temperatures, abrasion, and mechanical stresses. The temperature in the melting zone may be 2900°F or even higher, and lime added to flux the coke ash forms a corrosive calcium aluminum silicate slag, sometimes containing up to 10% iron oxide. The entire lining of a cupola is replaced only about once a year, but the melting zone usually must be replaced after each heat. Formerly all cupola blocks were made by the hand-molded process and many of them are still so made. They are rather porous, somewhat fragile, not accurate in size and shape, and do not stand the terrific abrasion and slag action in cupolas. Within the past few years cupola blocks made by the stiff-mud process using high-duty flint fireclay mixtures have been introduced. Brick so made are extremely hard and dense and afford better resistance to abrasion and slag penetration. Experience has shown that these brick give about three times as long life in the abrasive zone as older hand-made blocks.

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[9] M. C. Booze, "Refractories in Blast Furnaces and Coke Ovens," *Blast Fur. Steel Plant*, **14** [2] 86–88 (1926); *Ceram. Abs.*, **5** [4] 124 (1926).

Spalling requirements are also quite strenuous in cupolas. In ordinary practice, only about one hour is taken to heat the cupola before turning on the blast to melt the first charge. While this heating is severe, it is not so destructive as the common practice of cooling the lining at the conclusion of melting by dropping the bottom and spraying with water.

In large production foundries where pouring is done continuously, the slag penetration is so severe in the melting zone that hand-made blocks often burn out before a day's operation is completed. Stiff-mud brick usually give at least a full day's run. Cupolas using a high percentage of steel in the charge cut the fireclay brick in the melting zone worse than low steel charges. Silica blocks in some cases have given better service with high steel charges; life as long as two days has been experienced. Patching is usually done with silica splits and ramming mixes. In some cases water-cooling has also been used.

In large continuous foundries, if the 6-inch lining in the melting zone is burned out at the end of the day, it is usually economical to replace with new brick. When only part of the lining is burned out, patching is done with straight and split brick and daubing or patching mixtures. Patching mixes should be highly refractory and should consist of silica sand and plastic fire clay or crushed refractory fire brick and plastic fire clay.

Introduction of special high-cost refractories has met with little success because of cost. Natural silica stone blocks are widely used.

VIII. Malleable Iron Air Furnaces

The air furnace for melting malleable iron is a long and narrow reverberatory type, fired at one end with coal, oil, or gas. The furnace proper consists of a hearth, a rear bridge wall, two side walls, and a roof comprising removable bungs or arches. Bungs are made by fitting refractory shapes properly and by holding them in metal frames. Ordinarily the furnaces are about 6 feet wide and 18 to 20 feet long and have an average capacity of about 15 tons, although 20- to 25-ton sizes are common. Furnaces as long as 35 to 40 feet have been built with capacities up to 50 tons. In the large furnaces the length is 4 to 5 times the width. Most furnaces are charged through openings made in the roof by removing some of the bungs, but in a few installations charging is through doors in the side wall.

The furnace is brought to the melting temperature in about $1^1/_2$ hours, and the heat is finished in 5 to 8 hours. Manganese, silicon, and some iron are oxidized to form a corrosive slag that attacks bottom and side-wall refractories. A typical analysis of air-furnace slag follows[10]:

Ingredient	(%)
Iron as ferrous oxide (FeO)	28.80
Iron as ferric oxide (Fe_2O_3)	1.16
Manganese oxide (MnO)	4.85
Silica (SiO_2, etc.)	50.42
Alumina (Al_2O_3)	14.77

The metal may be heated from 2700° to 2850°F, depending on the type of material being made. The flame temperature probably is about 100°F higher than that of the metal.

Hearth bottoms, until recently, were made almost exclusively by tamping silica sand and/or fireclay grog and plastic clay onto the bottom. Such bottoms were gradually corroded by the slag and damaged during charging and skimming. The average bottom life was 12 to 17 heats.[11] During the past two years super-duty fireclay brick (cone 33) have been introduced into furnace bottoms. Life of 3000 to 7000 tons from a 9-inch bottom has been reported. Cleaner metal and less slag are claimed. High alumina refractories are also being used to a limited extent. Patching is done with silica-plastic clay ramming or patching mixes.

Side walls fail largely through corrosion by the slag and solid particles in the gases. Parts near the removable bungs are subject to spalling when the latter are removed. Abrasion during charging may be severe, especially if improperly done. A very refractory and very dense brick is desirable for side walls. The Joint Committee on Foundry Refractories[11] of the American Foundrymen's Association and the American Ceramic Society recommended medium firing of first-grade fireclay brick. The average wall life of a 20-ton furnace was 20 to 25 heats. During the past few years super-duty fireclay brick have been introduced into side walls, and the life has been approximately doubled. Patching is also resorted to in maintaining side walls.

Roof brick fail by corrosion of the solid particles

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[10] Industrial Survey of Conditions Surrounding Refractory Service in the Malleable Iron Industry. A.S.T.M. Standards on Refractory Materials, prepared by Committee C–8, p. 122 (1935).

[11] "Preliminary Report of the Sub-Committee on the Survey of Conditions in the Malleable Industry," *Trans. Amer. Foundrymen's Assn.*, **34**, 88–117(1926).

contained in the gas stream and by spalling, especially of the removable bungs. Improper setting of the clamps sometimes causes failure of bungs owing to too high pressure being exerted on heating. Failure of bungs by fusion has been reported. In using first-grade fireclay brick the average life, as reported by the above-mentioned Joint Committee, was 23 heats for charging bungs and 45 heats for firebox bungs with hand coal firing, and 14 heats for charging bungs and 22 for firebox bungs with pulverized-coal firing. The recently introduced cone 33 super-duty fireclay (flint) brick, however, usually have doubled bung life over that obtained from high-duty fireclay brick.

The malleable air furnace is an excellent example of improved performance and life that has resulted from the introduction of a new type of refractory fire brick. The older "soft" brick are rapidly being displaced by those of increased refractoriness and density with correspondingly greater resistance to slag action. These brick also have greater resistance to thermal shock than dense brick heretofore made.

Some manufacturers have introduced a change in the design of bung brick. This comprises an extra taper to permit an open joint $^1/_{16}$ to $^1/_8$ inch to allow for expansion and to eliminate pinching on the hot side.

Super-duty fireclay brick are also finding application in bridge walls.

IX. By-Product Coke Ovens

Since the iron and steel industry is dependent on coke, a brief description of a by-product coke oven and refractory requirements is given. The coking oven consists of a coking chamber, approximately 30 to 36 feet long, 10 to 12 feet high, and 16 to 22 inches wide. The charge is 10 to 16 tons of coal. The coking chamber should be as gas-tight as possible. It is heated by gas burned by preheated air in flues at the sides and bottom. In the Koppers oven, the flues are horizontal, and in the Semet-Solvay they are vertical. The charge is introduced through holes at the top. The coking process requires 12 to 30 hours. One inch per hour is considered good coking practice, although furnaces can be pushed to exceed this production.

Checkers are made of clay or silica brick, and the temperature ordinarily does not exceed about 2700°F. The oven chamber floor is made of fire brick, and the side walls and roof of silica brick. The charging holes and top mat use fireclay brick. The temperature within the oven chamber is about 2200°F. Refractory life is long; 20 to 25 years is usually expected. Refractory conditions are not particularly severe. The worst services are those of abrasion on the side walls and oven floor and of spalling. Dropping of damp coal into red-hot chambers subjects the silica brick to thermal shock, but usually the temperature is not lowered to the critical point. Spalling is more serious on heating and cooling the entire furnace; it is also more pronounced at the ends and charging holes. Fireclay brick are frequently used at the oven ends to prevent spalling.

Denser power-pressed silica brick have been introduced recently, but the life of a coke oven is so long that it will take some time to determine if brick so made possess any advantages over brick made by other processes. The claim made for denser brick is that the thermal conductivity is higher.

X. Copper Blast Furnaces

At one time copper blast furnaces were widely used but, with depletion of high-grade direct smelting ores, they gradually gave way to the reverberatory smelting furnace which is more adaptable to smelting of concentrates. Since copper blast furnaces are nearly obsolete and at the present are minor consumers of refractories, only cursory remarks are made about them in this paper. In general, blast furnaces were oblong in shape, usually 42 to 56 inches wide at the tuyères and from 12 to 87 feet long. They were entirely water-cooled and did not use refractories in the upper stack. The hearth employed fireclay brick, although silica and chrome brick were also used to a lesser extent. Refractories failed by corrosive action of copper matte and slag. Settling tanks for separation of matte also used refractories. At the present time, in the few operating furnaces, chrome brick are used to some extent in settling tanks.

XI. Reverberatory Copper Smelting Furnaces

Reverberatory smelting furnaces are somewhat similar in shape and design to open-hearth steel furnaces, but are fired only at one end. Oil, powdered coal, or gas are used as fuel. The operation in the furnace is largely one of melting. The ore smelted in reverberatories usually consists largely of copper and iron sulfides and gangue.

The charge ordinarily is partly roasted fine ores, converter slag, and enough fluxes to form the proper slag. At a few smelters,[12] unroasted or raw concentrates are smelted. The mass is fused at one end and flows to the other, or tapping end, where slag and matte separate and are removed by tapping. The slag is essentially iron silicate but varies in composition with the ore being smelted. In general, slags contain from 30 to 45% each of SiO_2 and FeO, 3 to 10% lime, and 6 to 10% Al_2O_3.

Flame temperatures are about 2700° to 3000°F at the firing end and 2000° to 2300°F at the flue end. The process is continuous and temperatures remain fairly uniform. During the 20th Century vast changes have taken place in the design and capacity of reverberatory smelting furnaces. Laist[13] gave an excellent summary of historical developments which, although limited to operations in Montana, may be taken as typical of practice in the western part of the United States. In some cases, smelting capacity has been trebled with no change in furnace size other than a slight increase in height. Firing has played an important rôle, and shorter, sharper flames have replaced the long, lazy flame of earlier days. Reverberatory smelting is essentially melting; capacity, therefore, is largely dependent on the rate of heating which in turn depends on refractory performance. Furnaces are usually 20 to 25 feet wide and 120 feet long. A fair-sized furnace handles 500 to 700 tons of calcine daily, although a few furnaces with 1100-ton capacity have been built.

Bottoms must be dense to prevent penetration of matte and strong enough to bear an enormous load of molten matte and slag. They are made of silica. The usual practice is to apply a layer about 2 feet thick and to heat until the surface is glazed. Preferably, a charge of slag is added before using the furnace. The bottom gradually becomes impregnated with slag, matte, and magnetite. In many smelters, the magnetite builds up in the bottom to such an extent that it becomes necessary to shut down the furnace for a clean-out. Brick bottoms have been tried, but the results were no better than with rammed bottoms.

Side walls are subject to attack by the corrosive iron silicate slag which attacks both acid and basic refractories at high temperatures.

In the early days charges were fed at the center near the firing end of the furnace. This practice continued until 1909 when side-charging was introduced to protect the side walls from corrosive action of slag.[14] With the exception of the interim during the famous Carson patent suit,[15] side-charging has been followed almost universally to date. During the period of center-charging, while the Carson suits were in progress, magnesite brick were widely introduced in the melting end of the furnace up to slightly above the slag line, above which silica brick were used. Water-cooling of the side walls in the smelting zone was also widely followed. At the present time all furnaces use side-charging and many of them have reverted to silica brick instead of magnesite, although many of the latter are still used. At the present time water-cooling is not widely employed. Most slags attack magnesite less than silica; magnesite, therefore, is particularly advantageous when the angle of repose of the solid feed is not great enough to protect fully the side walls.

The refractory problem has been somewhat complicated in the past two years by the large amount of quartzitic gold ores that are being treated. The resultant more siliceous slags attack magnesite somewhat more than silica brick. Silica brick have been found to stand up well in bridge walls under the present smelting practice. Chrome refractories have found only limited use in copper reverberatory furnaces as they tend to absorb slag and metal.

Concentrates or calcines are extremely fine and the dust problem is severe. Roof refractories are especially susceptible to dust attack. Until a short time ago silica brick were used exclusively in reverberatory roofs. Failure of roof brick is generally due to the fluxing of solids in gases and the consequent lowering of the fusion point. Oldright and Schroeder[16] showed that the dust from the charge, consisting mainly of iron and copper sulfides, penetrates the roof, forming oxides of iron and copper and causing the silica roof to

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[12] P. D. I. Honeyman, "Reverberatory Smelting of Raw Concentrates at the International Smelter, Miami, Ariz.," *Trans. A.I.M.M.E.*, **106**, 88 (1933).

[13] F. Laist, "History of Reverberatory Smelting in Montana," *ibid.*, p. 23.

[14] H. O. Hofman and Carle R. Hayward, Metallurgy of Copper, p. 190. McGraw-Hill Book Company, 1924.

[15] Carle R. Hayward, The Mineral Industry During 1929, p. 179 (Vol. 38). McGraw-Hill Book Co., 1930.

[16] G. L. Oldright and F. W. Schroeder, "Suggested Improvements for Smelting Copper in the Reverberatory Furnace," *Trans. A.I.M.M.E.*, **76**, 442–64 (1928).

melt several hundred degrees below the fusion point of silica brick. Samples of roof "drips" had fusion points of 2370° and 2600°F and contained 7 to 15% of iron oxide and 1 to 12% of copper oxide.

The average life of an 18-inch silica roof in the smelting zone is about 100 days, when furnaces are run at capacity production. Superimposing a new silica roof over the old one when the latter became dangerously thin has been practiced widely in the Southwest. The use of basic brick in reverberatory roofs has rapidly expanded during the past few years. Hard-fired magnesite brick, especially of the low-iron type, and chemically bonded or unburned magnesite are finding extensive use in portions of roofs near the charging holes. Ordinarily 15 or 16 courses of 18-inch magnesite brick are used as shoulders, *i.e.*, extending from the skewbacks, with silica brick in the center. In such a construction sprung arches can be used. Forsterite brick are also being introduced into roofs.

Unburned magnesite brick has found use in construction of a suspended roof for the smelting furnace of the Hudson Bay Mining & Smelting Company, Flin Flon, Manitoba, Canada.[17] Before the installation of magnesite brick, the average life of a silica brick roof was 54 days. A mechanically suspended roof for a section 27 feet long in the hottest zone of the furnace and extending the full 21½ feet of the furnace was built. In the first campaign the roof section ran 259 days.[17] The furnace was shut down for repairs of the silica roof in a colder section. This section was replaced with unfired magnesite brick to give a total length of 51 feet. The roof was more than a year old and still in operation at the time Heuer's paper was written. The Noranda Mines Ltd., Noranda, Quebec, has had a suspended magnesite roof of the unburned type in service for over a year. The International Nickel Co. of Canada, Ltd., Copper Cliff, Ontario, also has a suspended unburned magnesite roof.

Honeyman[12] reported longer refractory life when smelting raw concentrates than calcines. When smelting calcines, a furnace campaign rarely extended over 9 months, at which time a general repair was necessary. During the campaign at least two arch replacements were necessary in the smelting zone, and a 90-day run of the arch in the smelting zone was considered good practice. When his paper was presented, the campaign with raw concentrates had extended over two years, during which time the furnace was never completely cooled. Several replacements were made in the smelting zone, but the arch life in this section was increased from 90 days to 6 to 9 months. No repairs were made to the side walls during the campaign.

During the past few years some reverberatory furnaces have been insulated. In the case of one small furnace known to the writer, good refractory service was secured and fuel economy effected. A few large furnaces in the Southwest have tried insulation and report appreciable fuel savings.

XII. Copper Converters

Converters are furnaces in which matte is made into blister copper. The process comprises blowing air through the molten matte at a temperature of 2250° to 2400°F. The sulfur is oxidized and passes off as SO_2. Most of the iron is oxidized to FeO, which in turn is fixed as slag by the addition of siliceous material. Part of the iron is oxidized to Fe_3O_4, which is carried off in the slag. Heat is furnished by the oxidation of iron and sulfur and by the union of iron oxide and silica. Two types of converters known as the Great Falls and Peirce-Smith are used. In the former the horizontal section is circular and in the latter rectangular. Furnaces are mounted on trunnions for pouring slag and metal into ladles. The average charge fed to a Great Falls converter is about 45 to 50 tons, while the Peirce-Smith type is larger and the furnaces handle from 100 to 200 tons.

The converters are lined with magnesite brick, usually backed with 2 or 3 inches of dead-burned magnesite grains against the shell. A newly-lined converter is brought cautiously to red heat and then charged with low-grade matte which is blown for 10 to 15 minutes. Cold matte is then added to lower the temperature. The operation is repeated until the charge is converted to "white metal," which is poured. In this manner the brick lining is coated with a layer of magnetite, Fe_3O_4. The operations are repeated until a layer of magnetite completely covers the magnesite brick. If the magnetite lining is destroyed in operation, it is built up again in the same manner. A brick lining lasts 4 to 10 years, except at the tuyères where cutting is worse. Tuyères are water-cooled

[17] R. P. Heuer, "Refractories," *Trans. A.I.M.M.E.*, **106**, 278 (1933).

but the life is still quite short. Metalkase magnesite brick have found extensive use in converter tuyère zones, and a life of 3 to 9 months has been reported. Magnesite consumption is low in converters, being as low as 0.33 pound per ton of blister copper with about 5 pounds as an average figure.[18] Unburned magnesite brick are finding use in converter linings.

XIII. Copper Anode Refining Furnaces

Blister copper is refined in the anode furnace and cast into shapes or anodes for subsequent electrolytic refining. If the precious metal content is low, the material from the anode refining furnace may be the final marketable product. Most copper anode refining furnaces are of the reverberatory type. Typical furnaces are about 35 to 40 feet long and 14 to 17 feet wide, with a capacity of about 200 to 300 tons of copper.

Copper received from the converter in the molten condition or cold copper is charged into the furnace and then melted. The fuel is pulverized coal, oil, or gas, and firing is from one end. Air is blown into the bath to saturate it with oxygen. Sulfur is driven off as SO_2 and the base metals are oxidized and float to the surface. Silica sand is added to unite with impurities to form a slag, essentially copper silicate with impurities, which is skimmed off. The charge is deoxidized by covering with charcoal or coke and poling with green logs or poles. The copper oxide in the bath is reduced and the resulting copper contains approximately only 0.05% oxygen.

The entire cycle of charging, melting, refining, and casting requires 24 hours. The maximum temperature of roof and side walls is about 2800°F.

Bottoms are usually made of silica on top of clay brick and are fired in similarly to bottoms of reverberatory smelting furnaces, except that copper instead of slag is used. The bottom is covered with a few inches of copper that is slowly melted and absorbed. The temperature is lowered somewhat, a second portion of metal is charged, and the melting operation is repeated. These operations are repeated until all the copper that will be absorbed is taken up. Some of the copper is oxidized, and the resulting oxide reacts with the silica bottom, forming copper silicate which acts as a cementing agent. Care must be exercised to prevent the bottoms from raising. Ordinarily a forced circulation of air through pipes, running crosswise underneath the brickwork carrying the sand bottom, is employed for cooling. Bottoms ordinarily last from 3 to 5 years but require occasional patching.

The early refining furnaces used silica side walls. At present, magnesite brick are used at least to a few inches above the slag line, in which case silica brick is used the rest of the way. In most furnaces, however, magnesite brick are used exclusively in side walls. The copper silicate slag is more corrosive to silica than to magnesite brick. In poling, there is a certain amount of splashing that causes slag to attack refractories considerably above the slag or metal line. In some instances soda ash is used in refining and the slag so produced is very corrosive on silica refractories. Magnesite brick below the slag line are usually of the hard-fired or low-iron type. Above the slag line, unburned magnesite and Metalkase brick have been successfully used. The usual life of a magnesite side wall is about 200 heats. Resistance to spalling is required in refractories as changes in temperature are sometimes large and rapid.

Roofs are usually of silica brick. Copper oxide in the gases cuts silica brick badly, forming a slag that drips from the roof or runs down the side walls. As this slag is corrosive to magnesite brick it cuts the latter badly. To lessen this corrosive action a couple of courses of chrome brick ordinarily are placed between the silica and magnesite. Silica roofs last 100 to 125 heats.

Magnesite brick have been substituted in the roof from the uptake back as far as active corrosion occurs. Increased life has resulted. Forsterite brick have also been used in roofs with a life of 18 months and longer. Such an increase in life justifies the added cost. With both magnesite and forsterite brick sprung arches have been used.

XIV. Wire Bar Furnaces

Wire bar furnaces are used for melting cathodes and the removal of some impurities by oxidation and poling, similar to the process used in anode furnaces. In the case of wire bar furnaces the copper charge is entirely solid, whereas in anode furnaces it may be entirely molten. A less prolonged refining operation is required on cathodes.

Furnaces, in general, are similar to anode furnaces except that the bottom is usually of silica brick instead of silica sand. The bottom is

[18] H. O. Hofman and C. R. Hayward, Metallurgy of Copper, pp .220–23. McGraw-Hill Book Co., 1924.

generally a concrete base, the top of which is air-cooled and on top of this is an inverted arch of silica brick 24 to 36 inches thick. Side walls invariably are of magnesite to above the slag line. Silica or magnesite brick are used from the slag line to the skewbacks. Unburned magnesite and Metalkase brick have been successfully employed. Roofs use silica brick, although magnesite is being used with increased roof life, as in the case of anode furnaces.

Temperatures are about the same as in anode furnaces and, in general, the same remarks regarding refractory requirements and corrosion hold.

XV. Zinc-Distilling Furnaces

Formerly all zinc ores were treated by distillation in retorts. During the World War hydrometallurgical processes were introduced, and in the last decade the large continuous furnaces of the New Jersey Zinc Company were developed. Retort distillation processes, however, are still the principal zinc producers in the United States.

The retort process comprises mixing oxidized, roasted, or sintered ore concentrates with carbon (coke) in fireclay retorts and heating to reduce the zinc oxide to metallic zinc. The reduction is carried out at a temperature above the boiling point of zinc. The metal, therefore, is vaporized and passes out of the retort to a fireclay condenser, which is maintained at a temperature of 425° to 550°C, where it condenses to liquid zinc which is drawn off at intervals. Uncondensable and combustible gases pass from the condenser and are burned as they leave or pass into sheet-iron extensions, known as prolongs, which condense zinc that eludes the condenser in the form of fine particles of zinc and zinc oxide known as blue powder. In American practice prolongs are not used, but they are widely employed in European plants.

There are a great number of types of zinc-distillation furnaces, but American practice is largely confined to the so-called Belgian furnace. These are essentially long rectangular chambers of refractory material with a sprung arch. The furnace is usually divided into two equal parts by a middle longitudinal wall. The side walls are built with windows or pigeonholes for the insertion of retorts. The middle wall serves as a support for the inner ends of the retorts as certain courses of brick protrude to act as a shelf. The retorts stick out through the windows and the condensers are luted to the open end. Likewise, the retorts are luted to the windows.

Zinc retorts are cylinders, usually circular in shape and about 4 feet long. Formerly the usual inside diameter was about 8 inches, but within the last 3 or 4 years the tendency has been to increase the diameter so that the retort capacity is about 2 cubic feet. They are made at the zinc plant of specially selected clay. Formerly these were made by hand, but now hydraulic pressing is almost universally employed. Almost all American plants use Cheltenham clay which is mined near St. Louis, Missouri. Condensers are also made of clay, usually by a mechanical molding process. Retorts and condensers are carefully dried. Condensers are fired at 900° to 1000°C and retorts, which are fired to about 800°C, are transferred while hot to the distillation furnace. Within the past few years high-silica retorts made from about 50% of clay, by volume, 25% of silica flour, and 25% of grog have been introduced.[19] These are said to distort less in use than fireclay retorts.

Furnaces are fired either with natural or producer gas. Long furnaces, in which the course of combustion is longitudinal, are used with natural gas firing. A common furnace consists of a row of retorts five high and with 300 retorts to a side or 600 retorts per furnace. In some cases four-high furnaces are used, but the length is increased to handle approximately the same number of retorts. The producer-gas fired furnaces have about the same number of retorts as those using natural gas. This type of distilling furnace is recuperative, and heat recuperation may be obtained by means of a reversing-regenerative system, the countercurrent system, or by steam-boiler attachment.

The entire cycle of charging, distilling, and cleaning out of retorts requires approximately 24 hours. Each retort yields about 30 to 50 pounds of zinc per day.

Maximum temperatures inside the retort are ordinarily 1250° to 1350°C (2282° to 2462°F), although temperatures as high as 1450°C (2642°F) are sometimes used. The temperature outside the retorts is about 100°C higher, or up to 1550°C (2822°F). Silicates of iron, lime, etc., in the

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[19] G. L. Spencer, Jr., "High-Silica Retorts at the Rose Lake Smelter," *Trans. A.I.M.M.E.*, **96**, 119 (1931); *Mining and Met.*, **12** [289] 22–24 (1931); *Ceram. Abs.*, **10** [3] 199 (1931).

gangue form at about 1200°C, and as the temperature increases they become more fusible and attack the retort. The mixture of calcine and coke is added cold so the refractory must be resistant to spalling action. The retort must be strong, dense, resistant to the corrosion of the slag formed, and should not distort at high temperatures. High thermal conductivity is desirable. Silicon-carbide retorts, which are in use in a few plants, have been tried with varied success. The ordinary life of a clay retort is 30 to 40 days.

Side walls of furnaces are made of fireclay brick and the center wall and roof of silica brick. The ledge of the middle walls must be strong enough to support the load of retorts at the high temperatures involved. Refractoriness and strength are the prime requisites of furnace-structure refractories as practically no corrosive gases, slags, or dusts are encountered. The usual furnace campaign is about three years. High-alumina brick have been used in center walls, but in the past considerable trouble has been encountered by shrinkage. Modern volume-stable high-alumina brick are reported to be giving excellent service. Super-duty fireclay brick have also been tried with apparent success, but the history is too brief to draw definite conclusions.

(1) Continuous Zinc-Distilling Furnaces

The so-called New Jersey Zinc Company continuous process was first put in operation in this country in 1929. The process involves the continuous distillation of zinc in vertical retorts constructed of silicon carbide, the internal section of which is about 12 by 60 inches and the height 20 to 25 feet. The charge is briquetted coke and zinc ore or calcine. The briquets are fed at the top and gradually work down through the furnace. The zinc is distilled and condensed near the top, and the residues are discharged at the bottom. The furnace at Palmerton had 16 retorts with a daily capacity of 100 tons of zinc metal. The average retort life is estimated at three years.[20] The furnace is fired with producer gas.

An electrothermie-zinc furnace has been successfully operated by the St. Joseph Lead Company. So far, the process has been used only for the production of zinc oxide, but by addition of a suitable condenser it should be adapted to the production of metallic zinc.

[20] The Mineral Industry during 1934, p. 611, Vol. 43, McGraw-Hill Book Co., (1935).

The furnace is vertical, 57 inches in diameter, and approximately 30 feet high. The wall of the furnace is composed of circular sections of refractories supported on steel skew rings, which are electrically insulated from the column. The heating is supplied by electrical resistance of the charge. Electrical contact is made by three pairs of carbon electrodes, one of each pair being at the top and the other at the bottom. The operating temperature of the furnace is 1150° to 1200°C. The furnace charge is zinc sinter and coke. The refractory problem and the development of a suitable refractory were described by MacBride.[21]

A low-alumina fire brick having a low porosity gives the best results. MacBride gave the following requirements for refractories: (*a*) low porosity to prevent zinc penetration and its effects, (*b*) high melting point, (*c*) high electrical resistance at high temperatures, and (*d*) resistance to spalling and gradual disintegration due to slag, vapor, and gas.

XVI. Lead Smelting

At the present time lead is almost universally smelted in a blast furnace which resembles a copper rather than an iron blast furnace. The furnace is a rectangular shaft about 20 to 25 feet in height from tuyères to charging door. The charge is lead ore, usually in a sintered condition, slagging agents such as iron ore, limestone, or sand added to form a fluid slag, and coke to the extent of 12 to 15%. The width of the furnace at the tuyères is commonly about 48 inches and the length 150 to 190 inches. The sides of the furnace are boshed but the ends are straight. The crucible below the tuyères, in the active combustion chamber, acts as a reservoir for molten lead and matte. Lead is removed through a syphon. A typical lead blast-furnace slag will contain SiO_2 30 to 35%, Fe(Mn)O 30 to 35%, Ca(Mg)O 18 to 22%, Al_2O_3 3 to 6%, ZnO 5 to 9%, and PbO 1%.

The crucible depth is about 30 inches. The refractories are fire clay and the chief requirements are hardness, density, and resistance to corrosive action of lead. Chrome-base high-temperature cements for brick-joining materials lengthen crucible life.[22] The crucible extends

[21] W. B. MacBride, "Notes on Refractories for the Electrothermic Zinc Industry," *Bull. Amer. Ceram. Soc.*, 14 [12] 389–93 (1935).

[22] A.S.T.M. Standards on Refractory Materials, prepared by Comm. C–8, "Industrial Survey of Conditions

about 12 to 15 inches above the tuyères. Extending about 3 to 4 feet above the crucible is a water-cooled shell constructed of steel or cast iron. Brick extend above the water-cooled section to the top of the furnace. First-quality fire brick are required for 4 to 5 feet above the water-cooled section, and above this point dense, hard brick are used. Resistance to abrasion is the chief refractory requirement. Brick in the lower part of the shaft are not markedly attacked by chemical action as most of the reaction is below the firebrick lining in the water-cooled portion of the furnace. No trouble with spalling is encountered. The maximum temperature is about 2200°F in the zone of fusion.

In respect to life of blast-furnace linings, three years is reported as being good service.[23]

(1) Lead-Refining Furnaces

In lead-softening furnaces air is blown through the molten material to oxidize copper, iron, etc. The dross so formed is skimmed off and treated in a drossing furnace to slag off the iron and to tap a matte or speiss.

Drossing and refining furnaces are of the reverberatory type. The general construction of the reverberatory furnace for refining is the same as that for drossing or softening. They ordinarily have about the same dimensions, although the hearth of the refining furnace may be shallower. Soft coal or oil is used for fuel.

The bottom of a drossing furnace is an inverted arch of dense first-quality fireclay brick. The side walls are magnesite to the skews, although sometimes magnesite is used to a little above the metal line and 70% alumina brick from there to the skews. The roof is high-alumina or magnesite brick.

Lead-refining furnaces have capacities of about 60 to 300 tons. A 60-ton furnace is about 20 feet long and 12 feet wide. The maximum temperature encountered is about 2000°F; at this temperature refractoriness is not a prerequisite. Abrasion, caused by splashing of metal on the walls and by paddles skimming off dross, has some effect on refractory life but is not severe. The chief deteriorating factor on furnace linings is the lead and other oxides, such as antimony, that form on the surface of the bath. These oxides corrode silica or fireclay brick rapidly. Magnesite brick are almost universally used in the side walls at least to above the slag line. Low-iron magnesite brick have found extensive use in this field. High-alumina brick, because of density and resistance to corrosion, have found some application. Chrome brick are unsatisfactory because of attack by lead oxide. Other refractory requirements below the slag line, besides resistance to lead and antimony oxides, are density and mechanical strength. The brick should be true to shape so that they may be laid up without cracks, because, otherwise, molten lead will penetrate and escape. Above the slag line, first-grade fireclay brick that possess moderate resistance to spalling and lead and acid fumes are satisfactory. Roofs and bottoms are constructed of fireclay brick of intermediate or high-duty grade.

The life of the hearth brick varies from 4 to 6 months and the upper wall and roof from 6 months to a year.[24] The nature of the ore plays an important rôle in refractory life. High antimony content is conducive to shorter life.

XVII. Direct-Arc Electric Furnaces

The direct-arc furnace is used to melt cast and malleable iron, steel, and alloys. Acid-lined furnaces are usually used for iron, both acid and basic furnaces for steel, and ordinarily basic for alloy steels. Because the electric arc is in close proximity to the side walls, careful design and skillful operation are necessary to avoid excessive destruction of refractory linings. Excellent progress has been made in furnace design and instruction of operators, and today comparatively long lining lives are secured. Furnace capacities usually range from 3 to 20 tons, although furnaces as small as one ton are fairly common and one 80-ton furnace is in operation.

(1) Acid-Lined Furnace

An acid lining, such as is generally used in the gray cast-iron industry, has a bottom of rammed siliceous material, usually ganister. This is solidly rammed in place, ordinarily with an organic binder such as molasses, to a depth of about 18 inches. The side walls are silica brick with a space of about 2 inches between the brick and shell, which is filled with sand or other siliceous-insulating material. The roof is usually made of

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Surrounding Refractory Service in the Lead Industry," p. 133, 1935.

[23] A.S.T.M. Standards on Refractories, Comm. C–8, p. 135.

[24] *Ibid.*, p. 138.

silica brick. High-grade fire brick have been tried with fair success and the new super-duty fireclay brick appear to have a place as a roof refractory in electric furnaces. Bottoms are burned in by placing a layer of coke on broken electrodes on the silica bottom and lowering the top electrodes to form an arc. The surface of the silica bottom is sintered, but care must be exercised not to damage the silica brick in the side walls. Bottoms are patched with silica and burned in or sintered in the same manner as the original bottom. Generally in hot-patching some clay is added with the ganister. A properly burned-in bottom should last for a large number of heats before patching is required.[25]

Bottom life is somewhat longer in melting steel than cast iron. In melting steel, iron oxide is gradually absorbed by the silica and forms an iron-silicate bond. In melting cast iron, a possible explanation has been advanced that, owing to the highly reducing condition of the bath, the iron silicate bond is destroyed or does not form. This would account for some of the silica bottom "lifting."

Side walls are susceptible to spalling action, especially on weekend shutdowns. Iron-oxide particles arising from the bath also attack the silica refractories. The attack on the roof is similar to that on side walls. A recent change in design of furnaces, which as yet has not had wide application, permits raising and swinging the roof to add the charge rather than using a charging door. Charging time has been reduced to 5 minutes from $^1/_2$ to 1 hour and a 30% saving in refractories is claimed.[26]

The customary average roof life in a 3-ton acid furnace making steel castings is 200 to 300 heats, although as high as 1000 heats have been obtained. Wall life is about twice that of roofs. Wall and roof life is considerably longer in cast iron than in steel melting. Bottoms, however, require more attention.

(2) Basic-Lined Furnaces

Bottoms are made with tamped-in dead-burned magnesite or periclase with suitable bond, frequently sodium silicate. Linings are burned in similarly to acid bottoms. Patching is required after each heat and this is done with magnesite or sintered dolomite in much the same manner as that employed in open-hearth furnaces. The bottom portions of side walls are built of magnesite brick and the upper portion either of magnesite or silica brick. Low-iron magnesite brick have found extended use because of resistance to spalling. Silica brick are used in door jambs and arches that are subjected to mechanical abrasion. Roofs are constructed of silica brick. Super-duty fireclay brick have been tried, and a life about equal to silica brick has been reported.

Soler,[27] in discussing bottoms, states that the second or reducing slag being high in silica, lime, and fluorspar contains β-dicalcium silicate which on cooling (675°C) inverts to the γ- form with a 10% volume increase. This slag tends to creep into cracks which develop when the bottom cools, and on dropping below the transformation temperature the increase in volume causes rupturing of the bottom.

The reducing slag contains enough silica to have appreciable attack on magnesite side walls. Upper walls, when made of silica, are more susceptible to attack than in acid-lined furnaces because the slag contains lime as well as iron oxide. Higher temperatures are also employed. Splashings of slag attack the silica roof and the temperature is sometimes high enough to cause dripping. The greatest wear is around the holes through which the electrodes pass, and spalling is also more pronounced in that area. Chrome brick are seldom used in arc furnaces because they are reduced and contaminate the melt with chromium. A thin layer, however, is often used between the magnesite and silica brick in the side walls.

The life of refractories is variable, depending on the material melted and the temperatures employed. A fair average for roofs is 100 to 150 heats and about 300 for walls.

A special type of electric furnace is used in making ferro alloys. Usually this is an open-top furnace. The lining is ordinarily magnesite or periclase rammed in place with a binder. The lining is burned in with a wood fire and then with the electric arc. A considerable portion of the lining is consumed during each heat owing to the

[25] C. L. Frear, "Gray Iron Production in the Direct-Arc Acid-Lined Electric Furnace," *Trans. Amer. Foundrymen's Assn.*, **41**, 289 (1933).

[26] W. E. Moore, "The Manufacture of Plain Carbon Steel in Top-Charge Rapid Type Furnace," *Trans. Electrochem. Soc.*, **68**, 43 (1935) [Preprint No. 68-33].

[27] G. Soler, "Refractory Problems in Basic Alloy Steel Production," *Bull. Amer. Ceram. Soc.*, **14** [12] 383-88 (1935).

high temperatures used and the corrosive slag employed. Patching of sides and bottoms is required after each heat. Acidic refractory and carbon linings are used in making some types of ferro alloys.

XVIII. Indirect-Arc Electric Furnaces

Although not a large consumer of refractories, indirect-arc furnaces present unusual refractory requirements and a brief discussion is therefore included. This type of furnace was originally designed for melting brass and other copper alloys, but during the last few years it has found some use in melting iron and steel.

In melting copper alloys and the like the temperature is usually 1800° to 2400°F. When the charge is melted the furnace is rocked so that the entire wall, except the ends and that portion around the door and directly above, is washed with metal. Heat is transmitted to the charge by radiation from the arc and walls and by conduction from the hot refractory wall during rocking. The refractory wall, except the unwashed portion, is kept at approximately the same temperature as the metal bath.

Charging is intermittent and the refractories must be resistant to thermal shock. Joints must be tight to prevent penetration of metal, which results in increasing heat loss through the shell. Operating with the arc off center frequently causes end damage.

The lining for copper alloys is usually blocks of high-alumina fire clay or rammed mixtures of mullite compositions. Patching is done when required. Refractory life is dependent on the skill of the furnace operator and on the care that is given to patching. It may vary from 1000 to 3000 heats. Some operators prefer to reline a furnace before its life is exhausted in order to have a furnace better thermally insulated. It is a case of balancing refractory costs against heat losses.

The rocking furnace has found quite extensive application in making high-grade cast iron and in duplexing cupola iron. In a few plants alloy steel is being directly melted.

Temperatures near 3000°F are encountered in steel melting and the refractory problem is complicated, especially in the section above the door. Various types of refractories have been tried but the life is short. Among the refractories used are mullite ramming mixes or brick, silica, and high-alumina brick. Brick linings of 25 to 50 heats are reported. Monolithic linings now used are made of a mixture of sizes to give a strong, dense mass. The rammed mass is heated with the furnace empty to a temperature approaching fusion to vitrify throughout the entire depth. Low-iron magnesite brick linings have been used to a limited extent and have shown promise of longer life. Special brick and ramming mixes are being tried but sufficient time has not elapsed to test their true value. Tests have indicated a long life of linings made with dense blocks of cast mullite. The chief disadvantage of these blocks outside of cost is the difficulty of cutting them to shape. Lack of a suitable refractory is retarding the progress of rocking furnaces in steel melting.

In melting iron and duplexing, where such high temperatures are not encountered, lining life as long as 300 to 500 heats has been reported, using a rammed mullite lining properly burned in. Mullite crocks are also widely used.

Since slags, except iron oxide and the like, are rarely encountered in the indirect-arc furnace, the chief refractory requirement is ability to withstand high temperatures without fusion or deformation. Resistance to spalling is also necessary if cold charges are melted. The refractories likewise must have sufficient mechanical strength to withstand shock from charging.

XIX. Induction-Electric Furnaces

The vertical-ring high-frequency furnace is used for melting brass and presents some unusual refractory requirements. In this furnace heat is generated by the resistance offered by a wide but thin V-shaped loop of metal in a ring to induced current from a primary winding. The molten metal acts as the secondary winding of a transformer whose primary winding and core are within the secondary loop. Metal in the reservoir above feeds down into the ring where metal is circulated by the force of the electric flux.

To obtain high electrical efficiency the refractory lining between the metal and primary coil must be thin. On the other hand, it must be impervious and free of cracks because penetration of metal causes short circuiting. Diffusion of metal into the refractory also decreases electrical efficiency. Alloys, with pouring temperatures above 2500°F and those containing over 3% of lead, are particularly damaging in this respect. The metal in the V-section should be maintained

at 400° to 500°F above the pouring temperature.[28] In melting high-zinc brasses, zinc oxide is gradually built up in the loop. Furnaces that have run for a long time become choked up.[29] In order to operate the furnace molten metal must be kept in the loop. The lining of the loop can not be repaired without shutting down the furnace, and it is necessary to add molten metal before it can be again started. The action of the metal is not rapid enough to cause much abrasion, although high-melting point alloys cause some wear.

A lining of low thermal conductivity is desirable. A rammed lining of asbestos cement and fire clay gives satisfactory service especially for yellow brass. Adams reported[30] that one furnace melted 32 million pounds of yellow brass in 8 years of continuous operation with the same lining, while others in operation had melted 8 to 10 million pounds. This lining, however, is not satisfactory for the higher melting point alloys.

Considerable difficulty has been encountered in obtaining a satisfactory lining for alloys of pouring temperatures of 2500°F or higher. Preformed refractory clay linings have been made, but troubles due to thickness or porosity frequently were encountered. At the present time, at least one manufacturer is making preformed shapes of high-alumina clay, and better performance is claimed. Rammed linings of electrically fused magnesite bonded with sodium silicate are used for melting high-copper alloys, nickel brass, and copper. Life is about $^1/_{10}$ to $^1/_4$ that of asbestos-fireclay linings for yellow brass. Magnesia-alumina mixes are also used. In England a magnesite-rammed lining is also used extensively. The refractory is rammed around a metal templet inside the furnace and sintered in place by means of induced current. In melting nickel or its alloys, a single lining gives 50 to 250 heats[31] and 600 when melting copper.[32]

XX. High-Frequency Induction Furnaces

In the high-frequency furnace, metal in a refractory crucible is melted by its own resistance to an electric current induced from a winding surrounding the container. A variety of metals, alloys, and steel is being melted. The capacity varies from as low as 1 pound in laboratory furnaces to 5-ton commercial furnaces for steel melting. High-frequency current in small furnaces is obtained from mercury-gap converters, while larger furnaces are supplied from a motor-generator set.

To secure good electrical efficiency the walls of the container should be thin. Because the lining must be impervious to metal penetration, it must be dense and free from cracks. Refractoriness requirements depend on the metal being melted; for steel melting they must be high.

In small furnaces prefired crucibles are usually used. In larger furnaces linings are invariably rammed in place. A common method of preparing a lining comprises ramming the lining in place around a steel core and sintering by induced current heating. Linings so prepared remain unsintered a short distance outward from the inside and are thus better insulators than those that are completely sintered.[33]

Most commercial furnaces operate with basic linings, although silica linings are also widely used. Electrically sintered magnesite and magnesite-alumina mixtures are the most common basic linings. Dead-burned magnesite shrinks excessively in service and it is difficult to obtain a lining with freedom from cracks, but mixtures of dead-burned and electrically sintered magnesite are frequently employed with success. Rammed zircon sand has been tried, and recently calcined-kyanite rammed linings have been introduced.

Lining life is variable, depending on the materials being melted. Furnaces larger than 1-ton capacity have been operated for such a short time that information on refractory performance is meager.

XXI. New Developments and Trends in Refractories and the Effect on Metallurgical Industries

Since about 50% of all refractories are used in the iron and steel industries, naturally one looks first for the beneficial effect of refractory developments in this great field. In a brief paper, the entire field of refractory developments can not be covered in detail. Some manufacturer or user

[28] H. M. St. John, "Refractories for Brass Foundry Furnaces," *Trans. Amer. Foundrymen's Assn.*, **36**, 439 (1928); *Ceram. Abs.*, 7 [9] 619 (1928).

[29] H. W. Gillett and E. L. Mack, "The Electric Brass Furnace Refractory Situation," *Jour. Amer. Ceram. Soc.*, **7** [4] 288–89 (1924).

[30] Wm. Adams, Jr., "The Ajax-Wyatt Induction Furnace," *Trans. Amer. Electrochem. Soc.*, **57**, 462 (1930).

[31] D. F. Campbell, "Recent Developments in Electric Furnaces," *Jour. Inst. Metals*, **41**, 37–72 (1929).

[32] A. G. Robiette, "The Low-Frequency Induction Furnace and Its Scope," *Metallurgia*, **3**, 175 (1931).

[33] E. F. Northrup, "Tonnage Melting by Coreless Induction," *Iron Age*, **127**, 228 (1931).

may have found a specific refractory for a given use that fits his need in a satisfactory manner. Possibly the same refractory will not work so well in another plant using a somewhat different process or procedure. The plan in discussing the individual industries was to give a general picture of that industry as a whole, with no special reference to a given plant unless some outstanding performance deserved mention or a specific example covered the industry in general. In covering the individual industries, stress was laid on the effect of refractory developments on that particular industry. Since iron and steel plants are the largest refractory consumers, refractory performance, life, and the effect of new developments were covered somewhat more in detail than in the nonferrous industries. In order to keep this paper down in size, power plants were not considered. The discussion of the refractory problems of the individual industries described in this paper shows the marked improvement in refractory performance in many industries. A brief summary, however, of some of the newer refractories and some of their uses may be beneficial to those readers who are interested in refractories in general rather than in the application of refractories to given uses.

Basic brick are most widely used in the steel industry. The past decade has seen the introduction of the low-iron magnesite brick. Perhaps the chief advantage of this brick over high-iron magnesite is the markedly better resistance to thermal spalling. It also has somewhat better load-bearing capacity at high temperatures. It has found use in open-hearth, electric, and lead furnaces.

Chemically bonded or unburned basic brick is also a new product. Perhaps the chief advantage of these brick over burned magnesite is cheaper cost, and for that reason their widespread use is increasing. Unburned or chemically bonded brick, however, also possess some properties superior to most fired brick. Resistance to spalling is high and load-bearing capacity at high temperatures is better. Brick of this type are of two classes. One uses a chemical bond and is formed under high pressure with careful grading of particle size. Unfired brick made by the Ritex process are hydraulically pressed and employ a refractory chemical bond. Patents indicate that the bond is chrome ore, clay, and sodium acid sulfate. The other class is an improved Metalkase brick and comprises a chemically bonded brick with a steel cover or shield. This differs from the old Metalkase brick in that in the former loose grains were packed into a metal tube, whereas with the new, a brick is pressed and then covered with a metal shield. Unburned magnesite brick have found extensive use in basic open-hearth furnaces, not only below the slag line but they have, to a certain extent, replaced silica brick above the slag line in front, back, and end walls, ports, and downtakes. They have also given good service in soaking pits. Other uses are in copper converters and refining furnaces and, in the foregoing discussion of the copper industry, installations of suspended arches in copper reverberatory smelting furnaces were mentioned. Unburned magnesite brick have not been widely introduced in the reverberatory copper smelting furnaces in the United States but are widely used in Canada and Africa.

Recently an unburned chrome brick made similarly to unburned magnesite brick has appeared on the market. Chemical analyses[84] show that it is essentially a basic brick containing approximately 30% each of Cr_2O_3 and MgO, 18% Al_2O_3, 12% FeO, and 5% SiO_2. Its properties are such that it is widely used as a substitute for the older chrome and magnesite brick. In open-hearth furnaces it is being used above the slag line for construction of front, back, and end walls, and ports. The material is quite resistant to spalling.

Another new basic brick is forsterite, comprising mainly magnesium oxide and silica in a molecular ratio of 2:1. Their resistance to thermal spalling is about the same as that of low-iron magnesite brick. They have better strength at high temperatures than either chrome or magnesite brick. The widest application to date is in open-hearth bulkheads, and they are finding extended use in the copper industry. There are several installations of forsterite brick in roofs of copper-refining (holding) furnaces, and they are also being used as lining for rotary kilns.

Improved fired chrome and Kromag brick have been developed. These brick, fired at higher temperatures and chemically balanced by the addition of MgO to eliminate low-fusion ingredients, have given better life and service

[84] R. P. Heuer, "A New Application of the Ritex Process to the Manufacture of Chrome Brick," *Steel*, 97, 22 (Aug. 19, 1935).

than the older chrome brick. Their particular field of application is in the open-hearth steel industry.

Super-duty fireclay brick reach a high point in the development of strictly fireclay brick. These brick are frequently designated as a "cone 33" class and are made from flint fire clay in which incipient vitrification occurs only at high temperatures. Such brick are characterized by high density and volume stability. They have the greatest spalling resistance of highly refractory alumino-silica refractories of the ordinary price range. They are finding wide use in open-hearth checkers, glass-tank checkers, roofs of heating furnaces, malleable iron furnaces, blast-furnace stoves, and in roofs of electric melting furnaces.

High-alumina refractories have been widely used in large tonnages only during the past decade. The extended use is due largely to improved qualities and the growing demand for refractories that can withstand conditions too severe for fireclay or silica. High shrinkage on firing is an inherent characteristic of these materials, but volume-stable brick have been developed by prefiring a large portion of the raw mixture at high temperatures. Grain sizing and pressing under high pressures have contributed to such properties as low porosity, strength, low shrinkage, and resistance to spalling. One of the widest uses is in rotary kilns in the Portland cement, lime, and dolomite industries. They are also widely used in boiler installations; in the glass industry, in port and regenerator wall construction and as checkers; in center walls in zinc distillation furnaces; and in malleable furnace bottoms.

All silica brick were formerly made with a lime bond. Recently one manufacturer introduced a barium-type bond. Power-pressed silica brick have also been introduced.

There are innumerable new so-called super-refractory brick. Most of these aim at production of a material of high mullite content. Frequently the base of the raw material is natural-occurring kyanite 'or sillimanite. These brick at the present time are largely in the specialty class and their use is spread over an extremely wide field compared to tonnages produced. In a paper of this nature, it is impossible to discuss all brick of this class and, since refractories of large tonnage uses are being stressed, no attempt is made to discuss these in detail. Their sales are increasing and they well deserve the place they are taking in the refractory industry. With increased temperature demands in the metallurgical industries it is safe to predict that their use will continue to grow. One of their widest current uses is in the electric furnace industry. They also are used extensively in the glass industry.

Insulation of metallurgical furnaces is one of the distinct advances in the art. In the discussion of the open-hearth industry the fact was shown that not only is there a saving in fuel but refractory life is improved. Ten years ago open-hearth operators felt sure that if one insulated a roof the silica brick would melt. Owing to better thermal efficiency and less infiltration of air, however, bath temperatures can be secured with less fuel and air with the result that the corrosive action of gases has been decreased. Since brick are kept under less thermal gradient, there are fewer spalling troubles. With insulation, operators will undoubtedly try to obtain higher temperatures or to push production, and as a result increased demands will probably be made on refractories in the future.

The production of lightweight brick of sufficient refractoriness and strength for use as a structural unit has been a marked step in advance. The property of low thermal capacity makes them suitable for construction of intermittently operated furnaces that do not hold molten materials.

New refractories have been developed but old ones have also been improved. Even the production of new refractories with special properties is due in a large measure to improved methods of manufacture.

One of the most important advances is the care taken in grading and controlling the grain size of the refractory mix. This has resulted in better workmanship and refractories of higher density and better physical properties.

The increased use of power-pressing is worthy of note. This has resulted in a more homogeneous texture, freedom from molding imperfections, and lower porosity. De-airing methods have also improved power-pressed brick and have permitted higher pressures. Employment of vacuum de-airing in the production of auger or stiff-mud brick has also resulted in brick of better texture, density, and freedom from imperfections.

With the exception of basic and neutral brick, where the use of unfired brick is growing, the tendency has been to increase firing temperatures

to secure products that are better physically and to secure chemical union and physical transformations.

One of the most noticeable advances during the past decade is the uniformity and trueness to size of brick shapes. Tolerances have been decreased and this results in better furnace design and economy of operation. Large cracks between brick are largely eliminated.

Refractory mortars and cements have been vastly improved, and this in no small measure has contributed to the life and performance of refractories. Better plastic patching and ramming mixes have been produced and this has resulted in longer life.

Improvement in one type of refractory for a particular service usually is closely followed by improvements in other types used for the same purpose. If a suitable refractory is produced for a weak spot in a furnace, the operator pushes the furnace a little harder and some other point of weakness develops, and so on. With increasing demands on refractories we can expect that the manufacturer will attempt to meet them. The improvements of the last ten years show what can be done when the necessity arises. It is possible that the next decade will see even greater improvements than the past. Perhaps superrefractories, which today fill only a small niche in the total refractory consumption in the metallurgical industries, will play a far more important rôle in another decade.

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LABORATORY DE-AIRING MACHINE*

By Howells Fréchette

I. Introduction

A small laboratory de-airing extrusion machine which was devised for use in the Ceramics Laboratory of the Canadian Department of Mines, proved satisfactory for small-scale investigational work and would probably find a useful place in other laboratories.

The Machine

It is made from an ordinary horizontal cylindrical screw press of $4^1/_2$ by 15 inches inside dimensions. A vacuum line was tapped into the clay chamber as shown in Fig. 1 (p. 234.) To facilitate holding the vacuum, a hollow, internally threaded plunger rod passing through a stuffing box was used to propel the moderately loose-fitting plunger.

Inasmuch as the vacuum line enters the chamber behind the face of the plunger, no trouble has been experienced from clogging.

In use the plunger is retracted to its limit and the chamber filled from the die end with clay broken roughly to half-inch shreds. The die head is bolted on and the orifice covered with a greased piece of plate glass. The pump is started and, when the vacuum has built up to the desired degree, the plunger is screwed forward and the clay extruded. It is advisable to retard the advance of the clay at first by holding the glass in place until a clay seal in the die is assured.

Usually a die giving a column one inch by one inch is used but considerably larger sections have been made. Seven pounds of clay (dry weight) is a normal charge. With a "Hyvac" pump, a vacuum up to 29 inches is easily maintained.

III. Results

The machine is inexpensive to construct, easy to operate, and requires only ordinary care to make vacuum-tight.

It has been used with a variety of clays and has yielded useful information. It should also serve well for class-room demonstration of de-airing.

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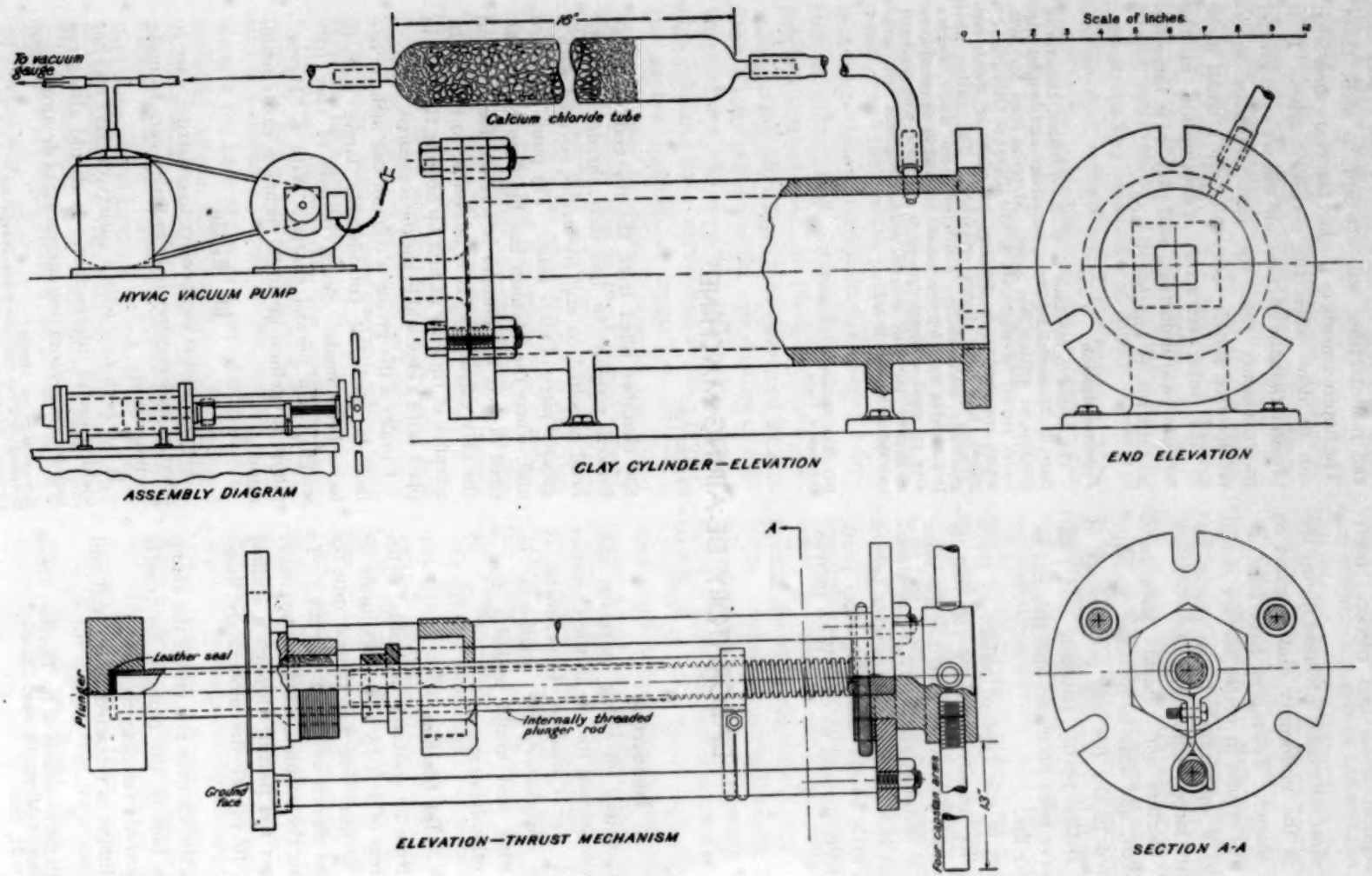

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FIG. 1.

CERAMIC ABSTRACTS

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The bold-face number following the journal name is the volume; the issue number is in brackets, followed by the page numbers, then the year in parentheses.

August, 1936

15—8

Abrasives

Abrasive products in the building industry. L. H. Milligan. *Ind. Eng. Chem.*, **27** [10] 1123–24 (1935).—Abrasive products are used to shape and surface many building materials by grinding, lapping, polishing, and sandpapering. For construction purposes abrasive products are used in floors, ramps, steps, and stairways that are subject to slipping hazards. Abrasive grains or abrasive aggregates imbedded in the surface of walkways contribute nonslip qualities and may increase wear resistance. The imbedding material may be metal, vitrified clay mixtures, cement, asphalt, or rubber. Illustrated. F.G.H.

Abrasive sleeve polishing wheels. Fred B. Jacobs. *Metal Cleaning & Finishing*, **8** [3] 121–27 (1936).—The abrasive sleeve polishing wheels are used for many operations which formerly were done by hand or on solid abrasive wheels. Lapless abrasive sleeves which have no objectionable projecting joints and the different types of polishing wheels for abrasive sleeves are described. The production of abrasive-coated cloth by the "electrocoating" process is discussed in detail. Illustrated. E.J.V.

Grinding and polishing of copper, light metal alloys, and tin plate objects. Rudolf Plücker. *Metallwaren Ind. & Galvano Tech.*, **33**, 165 (April 15, 1935); *Met. Abs.*, **7** [3] 133 (1936).—Detailed instructions are given. Difficulties in polishing tin plate are stressed.

Grinding and polishing of pocket knives. Fred B. Jacobs. *Metal Cleaning & Finishing*, **8** [4] 197–201 (1936).—The ordinary pocket knife requires a great many grinding, polishing, and buffing operations. The finishing procedure is described in detail. Illustrated. E.J.V.

Grinding processes. Gervase B. Seaton. *Indian Eng.*, **96** [20] 388–90; [22] 433–35; [25] 488–89; [26] 508–509 (1934).—The abrasives used today and yesterday are surveyed. Typical analyses of sand grindstones are given. **VI.** *Ibid.*, **97** [4] 40–41 (1935).—Corundum, its chemical composition, analysis, morphological characters and physical properties, color, location, natural formation, selection, method of cleaning, and preparation are described. **VII.** *Ibid.*, **98** [2] 63–64 (1935).—Diamonds as natural abrasives, their composition, formation, peculiarities and fracture, specific gravity and hardness, color and refraction, origin, selection, and practical application are described. **VIII.** *Ibid.*, [4] 132–33 (1935).—A study of the manufactured grinding wheels, their history, types, grinding speeds, cutting force, grits and grinds, etc., is given. A.P.S.

High-grade finishing of metallic surfaces. Rudolf Plücker. *Metallwaren Ind. & Galvano Tech.*, **33**, 478–81 (Nov. 15, 1935); *Met. Abs.*, **7** [3] 133 (1936).—P. discusses various polishing methods, such as rotating drums filled with sand and water, methods requiring pressure, drums containing balls and polishing agents, and polishing with the hardest polishing steels, agate, or hematite ("Glanzdrücken"). Finishing of metallic surfaces with emery by lapping, honing, and other grinding operations is also considered.

Impact abrasion hardness of certain minerals and ceramic products. Lowell H. Milligan. *Jour. Amer. Ceram. Soc.*, **19** [7] 187–91 (1936).

Polishing and buffing machines. Fred B. Jacobs. *Metal Cleaning & Finishing*, **8** [5] 279–84 (1936).—Improvements made in polishing lathes, flexible shaft machines, and belt polishers during the past year are discussed. Illustrated. E.J.V.

Small cylindrical grinder. Rene W. P. Leonhardt. *Indian Eng.*, **98** [6] 210–12 (1935).—A new precision cylindrical grinding machine made by Reiniger, Gebbert and Schall, and Erlangen, for the mass production of small, highly accurate parts is described. A.P.S.

Variability of garnet in granites. A. Brammall and S.

BRACEWELL. *Mineralog. Mag.*, **24**, 254–56 (1936).—Analyses of garnets from various specimens of the Dartmoor granite show that garnets from a single granite type may vary widely in MnO content. H.I.

PATENTS

Abrading and polishing compositions containing phenolic resins. BAKELITE G. M. B. H. (Ernst Elbel and Otto Süssenguth, inventors). Ger. 613,051, May 10, 1935 (Cl. 39*b*. 22); *Chem. Abs.*, **29**, 5549 (1935). See Brit. 374,033.

Abrading or surfacing apparatus. A. B. TOMS. Brit. 446,366, May 13, 1936 (May 13, 1935).

Abrasive paper. PAUL MÜNCH. Ger. 606,493, June 18, 1935 (Cl. 67*c*. 1); *Chem. Abs.*, **29**, 6386 (1935). An abrasive material is deposited on one side of an unsized paper sheet with the aid of a solution of a cellulose ester. After the solution has dried, the paper is impregnated from the other side with a sizing and waterproofing solution suitably with an alcoholic solution of resin size containing a solvent for the cellulose ester.

Abrasive saw tooth. R. N. S. MERRITT (Norton Co.). U. S. 2,043,184, June 2, 1936 (April 23, 1935).

Abrasive stones. L. I. GINZBURG. Russ. 38,009, July 31, 1934; *Chem. Abs.*, **30**, 1967 (1936). In the preparation of abrasive stones the binder is made from burned caustic dolomite together with a solution of $MgCl_2$ and $Fe_2(SO_4)_3$ solution.

Abrasive web. JOSEPH B. AUST (Carborundum Co.). Can. 353,795, Oct. 29, 1935; *Chem. Abs.*, **30**, 2342 (1936). A web of paper or cloth is coated with an adhesive such as glue and abrasive materials such as SiC. A sizing material, *e.g.*, nitrocellulose, is applied thereto. While the sizing material is wet an unctuous material such as mica, graphite, or talc is applied. The web is used for grinding soft woods or soft metals.

Abrasives. NORTON CO. Fr. 780,335, April 23, 1935; *Chem. Abs.*, **29**, 6010 (1935). Crystalline Al_2O_3 is made by melting impure aluminous ores in the presence of a carbonaceous reducing agent and an alkali or alkaline earth metal sulfide, or compounds capable of forming a sulfide under the reaction conditions, which gives rise to a vitreous matrix composed of the sulfide and residual impurities not reduced. The mass is cooled slowly to produce large crystals of Al_2O_3 and the mass is disintegrated by dissolving or hydrolyzing the matrix. Other abrasive substances may be prepared in like manner.

Buffing wheel. HARRY ZIMMERMAN (Beulah Belle Zimmerman). U. S. 2,043,189, June 2, 1936 (Jan. 17, 1935).

Cam grinding apparatus. C. J. GREEN (Norton Co.). U. S. 2,041,244, May 19, 1936 (March 11, 1935).

Centerless grinding machinery. G. E. MERRYWEATHER (Motch & Merryweather Machinery Co.). U. S. 2,043,972, June 9, 1936 (March 2, 1925).

Ceramic products. NORTON CO. Fr. 781,840, May 22, 1935; *Chem. Abs.*, **29**, 6384 (1935). Objects are made in granular ceramic material having a basis of Al or Si salts, bound by a vitrifiable clay material and fired in a ceramic furnace at vitrification temperature. The binder is composed of P_2O_5 or one of its salts with SiO_2 and Al_2O_3 in variable proportions but preferably in the proportion found in $AlPO_4$, the phosphate radical acting as a flux and being added as H_3PO_4 or a phosphate of NH_4, Na, or Al.

Crankpin grinding machine. H. A. SILVEN (Norton Co.). U. S. 2,041,215, May 19, 1936 (Sept. 29, 1934).

Cutting tool and method of making. F. O. JAQUES (L. S. Moulthrop). U. S. 2,041,347, May 19, 1936 (Feb. 23, 1933). (1) A method of forming a cutting tool for cutting hard metals comprises heating a metal alloy shape containing cobalt and one or more metals of the chromium group to a temperature approaching the melting point of the metal alloy and immediately compressing the metal alloy to compact the metal particles and improve the cutting qualities of the alloy. (4) A cutting tool bit for cutting hard metals has a portion consisting of an alloy containing cobalt and one or more metals of the chromium group, the molecular structure of which has been modified by compression while at a high temperature to compact the alloy metal and reduce the bulk thereof.

Dust-removing means for valve seat grinders, etc. E. A. HALL (Hall Mfg. Co.). U. S. 2,042,782, June 2, 1936 (May 26, 1934).

Feeding device for grinders. K. L. HERRMANN (Bantam Ball Bearing Co.). U. S. 2,041,764, May 26, 1936 (April 30, 1934).

Freehand grinding machine. EVERARD STUBBS. U. S. 2,043,017, June 2, 1936 (June 7, 1934).

Grinding machine. E. F. HAAS (Cincinnati Grinders, Inc.). U. S. 2,043,408, June 9, 1936 (Feb. 14, 1931).

Grinding and polishing agent. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Fr. 780,124, April 19, 1935; *Chem. Abs.*, **29**, 6010 (1935). The binder used for the abrasive is composed of artificial resins transformed by a preliminary treatment, *e.g.*, condensation and (or) polymerization, so as to allow heating the abrasive substance interspersed with cavities up to the temperature necessary to give the desired solidity, while avoiding all exaggerated softening or liquefaction of the resin. The cavities are produced by substances liberating gas bubbles during the heating.

Grinding and polishing apparatus for tools, etc. VOMAG BETRIEBS A.-G. Brit. 446,705, May 20, 1936 (April 6, 1934).

Grinding tools. ALLGEMEINE ELEKTRICITÄTS-GES. Ger. 611,860, April 8, 1935 (Cl. 40*b*. 17); *Chem. Abs.*, **29**, 5801 (1935). A hard sintered alloy containing diamond dust for making grinding tools, etc., is obtained by adding diamond dust to an alloy of W carbide and a metal of the Co group and pressing the mass to shape at 1350 to 1380° and 70 kg./sq. cm. pressure.

Grindstones. WILLIAM H. MCGILL. Can. 355,991, Feb. 18, 1936; *Chem. Abs.*, **30**, 2720 (1936). To increase the wet strength of grindstones made of sandstone, the stone is impregnated with a synthetic resin in one of its lower stages, such as formaldehyde resin, dissolved in alcohol with about 10% of a plasticizer for the resin. A solution of 6 lb. of alcohol to 1 lb. of resin will readily penetrate the stone. It is then heated to 200°F to evaporate the alcohol and then heated to 330 to 350°F to convert the resin into insoluble and infusible form and into one of its higher stages.

Knife grinder. W. W. HARTMAN. U. S. 2,041,340, May 19, 1936 (May 16, 1934). A grinder adapted to sharpen an elongate cutter blade, a grinding wheel, a frame, and a rock-shaft rotatably mounted on the frame.

Method of making an abrasive cutting tool. F. O. JAQUES (L. S. Moulthrop and Shirley Harrington). U. S. 2,041,346, May 19, 1936 (Feb. 23, 1933). The method of making a diamond cutting tool comprises forming a recess in a tool body, positioning two or more diamonds in the recess in a certain definite relationship with each other and with the tool body while surrounding the diamonds on all sides with a comminuted metal alloy comprising cobalt and one or more metals of the chromium group, providing a metal closure for the recess, heating the tool body to a temperature approaching the fusion point of the comminuted metal, and immediately subjecting the tool body to a pressure sufficient to completely unite the metals and effect a substantial compression of the same.

Method of manufacturing rubber-bonded abrasive articles. C. S. NELSON (Carborundum Co.). U. S. 2,043,766, June 9, 1936 (Oct. 5, 1934). The method of making a distributable rubber mix for use in the manufacture of rubber-bonded abrasive articles comprises preparing a mixture comprising abrasive grains, an artificial dispersion of previously coagulated rubber, and a vulcanizing agent, drying the mixture until its moisture is substantially all removed, heating the mixture to between about 225°F and 250°F, and disintegrating the mixture to form a mass of individual abrasive granules and clusters of a few granules to which is attached a dry and vulcanizable rubber compound.

Polishing or abrading materials. FRITZ SIMON. Ger. 614,237, June 4, 1935 (Cl. 39*b*. 21); *Chem. Abs.*, **29**, 6010 (1935). Addition to 580,206 (*Ceram. Abs.*, **13** [8] 197 (1934)). The powdered resin used in the process of Ger. 580,206 is replaced by powdered asphalt or like bituminous material, or by a mixture thereof with resin.

Polishing composition. WILLIAM W. LEWERS (Canadian Industries, Ltd.). Can. 353,054, Sept. 17, 1935; *Chem. Abs.*, **29**, 8183 (1935). The composition contains an abrasive, an oil, gum tragacanth, glycerol, water, and a metallic salt added in amount sufficient to be a stabilizer but insufficient to cause extensive flocculation.

Roll grinding machine. A. G. BELDEN AND H. J. GRIFFING (Norton Co.). U. S. 2,040,820, May 19, 1936 (Jan. 14, 1936).

Rotary grinding substances. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER (Theodor Pohl and Josef Schneider, inventors). Ger. 612,918, May 11, 1935 (Cl. 80*b*. 11); *Chem. Abs.*, **29**, 6386 (1935). Corundum, etc., is mixed with a binding agent containing a substance giving off a gas to produce a porous structure. Thus corundum is mixed with clay homogenized with H_2O_2 solution. The dry molded product is porous owing to the O evolved. A small amount of soap may be added to facilitate the production of the porous structure.

Safety tread. EDWARD VAN DER PYL (Norton Co.). U. S. 2,041,032, May 19, 1936 (Sept. 5, 1933). A safety tread tile comprises a backing of completely vulcanized rubber in a hard, rigid, nonyielding, nonflexible condition, yet capable of being sufficiently resilient to withstand the shocks and stresses of pedestrian traffic, and an antislipping surface layer of hard rubber vulcanized to a hard rigid condition and shaped to provide a plane tread surface and a curved nosing, both of which contain aggregates of abrasive grains bonded by a ceramic bonding material.

Silicon carbide. CARBORUNDUM CO., LTD. Brit. 429,616, June 4, 1935; *Chem. Abs.*, **29**, 7028 (1935). In manufacturing porous SiC for use as a packing in fractionating columns, a mixture containing a small amount of sawdust with up to 97.5% of amorphous SiC ("fire sand") is packed around a graphite core in an electric furnace, the usual mixture of coke, sand, sawdust, and salt is packed around this layer, and the charge is raised to about 2000°. Crystals of large size are formed around the core and these may be crushed to pieces of 1- to 3-in. diameter for use in stills. In an alternative method, ordinary SiC, reduced to the size of grit, is moistened with a binder, *e.g.*, the residue obtained by evaporating sulfite cellulose lye, and molded into spherical or other forms which are heated in a sand-C mixture or in a reducing atmosphere to 2000 to 2600° to effect recrystallization of the SiC with the formation of large crystals.

Valve grinding disk for grinding engine valves and valve seatings. W. GAINES. Brit. 446,271, May 13, 1936 (Oct. 23, 1934).

Valve seat grinding machine. F. O. ALBERTSON (Albertson & Co., Inc.). U. S. 2,042,759, June 2, 1936 (Dec. 23, 1932; renewed May 11, 1935).

Art and Archeology

Ceramic art at Ohio State University. DEPARTMENT OF FINE ARTS, OHIO STATE UNIVERSITY. *Bull. Amer. Ceram. Soc.*, **15** [6] 233–38 (1936).

Chinese painted brick from the Eumorfopoulos collection. B. GRAY. *Brit. Mus. Quart.*, **10** [1] 3–7 (1935).—The earliest painting in the collection is not on silk or paper, but on hollow clay brick of the Han period. Illustrated. H.H.S.

Fourteenth-century Egyptian albarello. R. L. HOBSON. *Brit. Mus. Quart.*, **9** [2] 51–52 (1934).—A new museum acquisition is illustrated. H.H.S.

Greek aryballos vases. F. N. PRYCE. *Brit. Mus. Quart.*, **10** [1] 9 (1935).—Two aryballoi, or oil bottles, are illustrated. H.H.S.

How glass is decorated. ANON. *China, Glass & Lamps*, **55** [1] 27–31 (1935).—A brief outline is given of decorative effects and how they are obtained. Types described are cutting, etching, engraving, frosting, cased glass, reeding, threading, mosaic, and painted colors. G.M.P.

Mycenaean beehive tomb. A. J. B. WACE. *Illus. London News*, **188** [5052] 276–79 (1936).—Some of the finest vases that have been brought to light in Greece are from a newly discovered tomb at Berbati, near Mycenae, dating from B.C. 1400. Illustrated with 16 photographs. H.H.S.

Pentateuch bowl. CHARLES MARSTON. *Illus. London News*, **188** [5054] Supp. I (1936).—An inscription of importance to Biblical criticism, suggesting that the Pentateuch was written in the oldest-known alphabetical script, occurs on a bowl found by the Wellcome Expedition at Lachish in Palestine. A colored reproduction of the bowl is shown. H.H.S.

Porcelains from China. ANON. *China, Glass & Lamps*

55 [4] 91–94 (1935).—A description is given of the types of ware made during the different periods of Chinese art from B.C. 1122 to A.D. 1644. Illustrated. G.M.P.

Pottery commemorating Sunderland Bridge. R. B. Hepple. *Notes & Queries*, **169** [Nov. 26] 352; [Dec. 21] 446 (1935).—In 1793 an iron bridge was built over the River Wear, the expense being met by a lottery. Pottery with designs of the bridge was issued by Phillips, Hylton Pottery, and S. Moore, Southwick, in frog and other ware. H.H.S.

Prehistory in Portugal. Anon. *Discovery*, **17** [194] 53–56 (1936).—Relics found at the ancient hill-settlements of Citânia de Briteiros and Sabroso, in northern Portugal, indicates that a cognate culture flourished in late prehistoric times all along the Atlantic seaboard. H.H.S.

Ras Shamra finds. C. F. A. Schaeffer. *Illus. London News*, **188** [5053] 307–11; [5054] 372–73 (1936).—Thirty-one photographs of the French Expedition's work at ancient Ugarit in northern Syria include plaques in soft porcelain, tomb vases, etc. H.H.S.

Road to empire: I. Jotham Johnson. *Sci. Amer.*, **154**, 301–303 (1936).—Excavations were undertaken at previously unexplored Minturnae, settled first in pre-Roman times. It is located 50 miles north of Naples. Remains were found of a pre-Roman wall of limestone masonry and a Roman wall of ashlar. An early Roman temple was made of wood and decorated with terra cotta tile and plaques. Another temple, a few years earlier, was of concrete. W.D.F.

Solar tree myth designs. O. Janse. *Illus. London News*, **188** [5055] 394–96 (1936).—Terra cotta brick and pottery from Indo-China bearing designs of the solar tree are illustrated. H.H.S.

Stained glass creed. Lawrence Saint. *Bull. Amer. Ceram. Soc.*, **15** [6] 238–41 (1936).

Style trends, modern or traditional? Anon. *China, Glass & Lamps*, **54** [11] 13–16 (1935).—At a conference of the American Institute of Decorators, Donald Deskey, a modern industrial designer, gave 19 statements as topics for debate. He upholds the modern style. Manufacturers of china and glassware are concerned with interior decoration as backgrounds for tableware and decorative articles. G.M.P.

BOOKS

Chinese Art. R. L. Hobson. Macmillan Co., New York, 1927. 15 pp. + 100 plates in full color. Price $8.00. In Hobson's fifteen-page introduction, Chinese art as a whole is rapidly surveyed. Brief mention is made of important rulers and an occasional artist whose name has survived the constantly changing China of the last two millenniums. Examples of Chinese art work are shown in the colored illustrations selected by Messrs. Benn from expensive monographs prepared by specialists in ceramics, sculpture, painting, and so forth.

According to Hobson, p. 14, "Nowhere, perhaps, is the supremacy of the Chinese so marked as in the ceramic art. The satisfying shapes of the T'ang pottery, the subtly refined monochrome porcelain of the Sung, and the gorgeous Ming three-color ware are things unrivalled. The influence of the Chinese potter is world-wide, and even when he had passed his prime his work was good enough to be a model to the nascent porcelain industry of Europe. Indeed his ceramic skill is almost uncanny, and we are at a loss to say which is most admirable, his manipulative power, his instinct for form and ornament, or his sense of color, which is as daring and as true as Nature's own . . . . so much of Chinese art work is good, and so little really bad, that in a contest of artistry they would surely be acclaimed the most gifted nation in the world."

Fifty-eight of the color plates and four of the publications listed in the bibliography deal with ceramics.

Henry H. Smith

Development of Sumerian Art. C. L. Woolley. Faber & Faber, London, 1936. Price 30s. Reviewed in *Discovery*, **17** [194] 60 (1936). H.H.S.

Walters Art Gallery, Handbook of the Collection. Dorothy Kent Hill, Marvin Chauncey Ross, Dorothy Miner, Edward S. King, and George Heard Hamilton. Walters Art Gallery, Baltimore, Md., 1936. 176 pp. Illustrated. Price, paper bound 50¢, cloth $1.00. This well-printed handbook contains brief surveys of the various art periods represented in fourteen of the Museum's fifteen galleries. Egyptian, Mycenaean, Grecian, Persian, and Byzantine ceramic ware are illustrated. Examples of 13th Century champlevé enamel and stained glass windows made in the same century for the Cathedral of Sens are also shown. Renaissance terra cotta and majolica are illustrated. In the discussion of 18th Century art, Sévres porcelain, pieces from Derby-Chelsea, and an example of Wedgwood's jasper ware are included. In a brief discussion of Far Eastern art, examples of the work of the Chinese potters are shown. Each period is discussed by the Gallery authority on that period and the representative examples included in the handbook aid in giving the layman a general idea of the relation of the different periods to one another and provide a background for those interested in studying the collection more thoroughly.

Henry H. Smith

PATENTS

Decalcomania prints and papers. J. MacLaurin. Brit. 447,230, May 27, 1936 (June 4, 1935).

Designs for:

Bottle. R. H. Dallas (Glass Containers, Inc.), U. S. 99,757, May 19, 1936 (Nov. 25, 1935). Frank McLaughlin (Carr-Lowrey Glass Co.). U. S. 99,819, May 26, 1936 (March 26, 1936). U. S. 99,880, June 2, 1936 (April 4, 1936). Frasier Smith (Hazel-Atlas Glass Co.), U. S. 99,916, June 2, 1936 (Jan. 3, 1935).

Eyecup. C. G. Hilgenberg (Carr-Lowrey Glass Co.). U. S. 99,865, June 2, 1936 (April 17, 1936).

Glass bottle. W. E. Mackelfresh, Jr. (Ball Brothers Co.). U. S. 99,750, May 19, 1936 (Oct. 15, 1935).

Glass floral bowl. T. C. Heisey (A. H. Heisey and Co.). U. S. 99,799, May 26, 1936 (March 7, 1936).

Glass goblet. J. G. Funfrock, U. S. 99,744, May 19, 1936 (March 12, 1936). D. K. Irwin (Morgantown Glass Works), U. S. 99,676, May 19, 1936 (March 12, 1936).

Glass vase. T. C. Heisey (A. H. Heisey & Co.). U. S. 99,798, May 26, 1936 (Feb. 26, 1936).

Globe for lighting fixtures. J. C. Dunn and Max Klein (Gillinder Brothers, Inc.). U. S. 99,743, May 19, 1936 (Dec. 30, 1935).

Goblet. D. C. SLOAN (United States Glass Co.). U. S. 99,898 and 99,900, June 2, 1936 (March 31, 1936).

Lighting fixture globe. S. S. DAUMAN. U. S. 99,742, May 19, 1936 (April 10, 1936).

Plate. D. C. SLOAN (United States Glass Co.). U. S. 99,899, June 2, 1936 (March 31, 1936).

Spark plug. P. D. JACKSON. U. S. 99,869, June 2, 1936 (Oct. 7, 1935).

Water-closet. T. C. HOBBS (Briggs Mfg. Co.). U. S. 99,800, May 26, 1936 (April 4, 1936).

Glazes. FRITZ HERMANN ZSCHACKE. Ger. 624,042, Jan. 10, 1936 (Cl. 80*b*. 23.03); *Chem. Abs.*, **30**, 2720 (1936). As opacifying agents for glazes, use is made of arsenates of alkaline earth or heavy metals or of arsenites of these metals together with an oxidizing agent. Phosphates may be used, in small proportion, in association with the arsenates. Specific compositions are described.

Cements

Artificial pozzolana, "surki." J. M. LACEY. *Engineer*, **157**, 230–31 (March 2, 1934); reprinted in *Indian Eng.*, **95** [13] 253–54 (1934).—The Indian "surki," one of the artificial pozzolanas, is made from (1) pure clay free from sand with normal calcination (Vicat), and (2) marly clays which contain carbonate of lime, with a calcination of 1300 to 1500°F. Uses and applications are also described. A.P.S.

Means of controlling gypsum molds. L. A. SHMELEV, Z. YA. BOKUM, AND E. A. USPENSKAYA. *Keram. i Steklo*, **12** [1] 32–34 (1936).—Experiments to determine the speed with which gypsum molds absorb water are described. Diagrams show the results. M.V.C.

Properties of plaster of Paris and effects of varying the manipulation. H. D. KIMBALL. *Dental Cosmos*, **76**, 1281–90 (1934); *Brit. Chem. Abs.-B*, **54** [45] 993 (1935).—The strength of casts increased with declining H_2O content of the mixture, 2 parts by weight of plaster and 1 part of H_2O being most satisfactory. Mechanical spatulation was more efficient than hand spatulation. Borax retarded setting and weakened the cast.

PATENTS

Baffled rotary kiln. THORKILD AVNSOE AND EJNAR POSSELT (International Cement Corp.). U. S. 2,042,494, June 2, 1936 (March 9, 1934).

Cement composition. GEORGE WITTY. U. S. 2,043,641, June 9, 1936 (July 24, 1935). A cement composition consists of granulated blast-furnace slag, calcium hydroxide, calcium sulfate, dextrin, silica, glass sand, potassium sulfate, and magnesium silicofluoride.

Cement and process for making. SOUTHERN STATES PORTLAND CEMENT CO. Brit. 447,722, June 4, 1936 (Nov. 1, 1934).

Cement for uniting ceramic materials to metal. ROBERT BOSCH A.-G. Fr. 790,567, Nov. 23, 1935; *Chem. Abs.*, **30**, 3192 (1936). The cement contains finely ground Al_2O_3 95 to 98.5 and fluosilicates, preferably Mg fluosilicate, 0.2 to 5%. The mixture is caked by a concentrated solution of soluble glass.

Gypsum molds. PORZELLANFABRIK KAHLA. Ger. 611,550, March 28, 1935 (Cl. 80*b*. 24.04); *Chem. Abs.*, **29**, 6009 (1935). The surfaces of gypsum molds for casting ceramic bodies are strengthened by impregnation with a solution of resin, shellac, colophony, varnish, etc., in oil of turpentine, benzine, C_6H_6, petroleum, etc.

Manufacture of Portland cement. H. R. DURBIN (International Cement Corp.). U. S. 2,042,833, June 2, 1936 (Aug. 26, 1933). In the manufacture of Portland cement, the steps of burning a cement mixture containing an excess of free lime to produce a clinker, grinding the clinker, and separating the fines containing the excess of free lime above that permissible in the finished cement.

Process of making clinker for the production of cement. F. KRUPP A.-G. Brit. 446,952, May 20, 1936 (Oct. 18, 1934).

Enamel

Aspects of plant layout and production. J. T. GRAY. *Foundry Trade Jour.*, **52** [964] 107–11; [965] 123–26; [966] 145–47 (1935); see *Ceram. Abs.*, **15** [1] 9–10 (1936). H.E.S.

Black enamel for hearth plates. VIELHABER. *Emailwaren-Ind.*, **13** [1] 1–2 (1936).—The composition of black enamels used for hearth plates in gas ranges is discussed. These enamels have a low resistance to acids from cooking. The replacing of a part of silica by TiO_2 is recommended. In this way the SiO_2 or TiO_2 content of the enamel may be increased to raise its durability. M.V.C.

Control of color in the enameling plant. D. O. KOCH. *Metal Cleaning & Finishing*, **8** [3] 139–41 (1936).—The process of manufacturing ceramic pigments is described. Mill-batch comparisons are made under exacting conditions, as follows: (1) identical mill batch, (2) ground to same fineness, (3) enamel applied to same weight per unit area, and (4) fired side by side with standard. For a specific coloring pigment the final shade of color obtained is dependent on the chemical composition of the enamel frit. Accurate control of color requires standardization of the milling operation, standardization of enamel consistency, and accurate control of time and temperature in the firing operation. Color matching should be done under standard artificial sunlight. E.J.V.

Determination of the adhering strength of enamel. VIELHABER. *Emailwaren-Ind.*, **12** [50] 401–402 (1935).—Various methods used to determine the adhering strength of enamel are mentioned, and the apparatus of Kinzie and Miller (*Bull. Amer. Ceram. Soc.*, **14** [11] 371–73 (1935)) is described. M.V.C.

Drying enameled hollow ware. VIELHABER. *Emailwaren-Ind.*, **13** [5] 36–37 (1936).—The best means for eliminating water and moisture from the enamel before it is fired consists in blasting air into the body or sucking air out of it; the latter method is more efficient. M.V.C.

Enamel finishing of pressed-steel sinks. C. F. MAYER. *Ind. Heating*, **3** [5] 329–31 (1936).—Arrangements for dry-

ing the products by waste heat before enameling and direct firing are discussed as to their economy. A few installations are described. M.H.

Grinding operation. VIELHABER. *Emailwaren-Ind.*, **12** [50] 402–403 (1935).—The importance of constant control of the operation of grinding enamels is discussed with special regard to the speed of revolutions of mills. M.V.C.

Methods of enameling. WALTER OBST. *Emailwaren-Ind.*, **13** [10] 89–90 (1936).—Several American and French methods relating to the enameling of steel, decoration of enamels, and manufacture of luminous enamels are briefly discussed. M.V.C.

Outline and construction of electric enamel kilns. L. MOENNICH. *Emailwaren-Ind.*, **13** [9] 74–79 (1936).—Data on various electric kilns for melting enamels are given and their properties and advantages are pointed out. M.V.C.

Practical results of scientific researches in enameling. R. ALDINGER. *Glashütte*, **66** [9] 157–60 (1936).—Three important branches of enameling technique, *i.e.*, opacification, adherence, and tensions, have been investigated in the last few years. The problem of opacification has been almost entirely solved by the work of Zschimmer, Andrews, Wiedemann, and Kerstan. If fluorine compounds are used, opacification is due to the precipitation of sodium-fluoride crystals. In the case of fluorspar, calcium-fluoride crystals are obtained. Light striking these crystallites is reflected, diffracted, and diffused. Other opacifiers also give crystals, such as SnO_2, Sb_2O_3, except zirconium derivatives, which give silicates of zirconium slightly soluble in enamel and present in noncrystalline drops, forming a kind of emulsion. Opacification by cerium oxide has not yet been studied. In order to get the best results with an opacifier, an enamel should be used which dissolves it slightly; alumina, lime, and zinc oxide can be used. Antimony trioxide is preferred, the nonpoisonous antimonate being used only for kitchen utensils. Opacification by gas is an interesting adjunct; water of hydration of pipe clay, gas given off by carbonates, nitrates, and fluorides give minute bubbles contributing to the opacification. Zschimmer and Meures, who have contributed much to the question of the adherence of enamel to iron, examined the process of firing mixes on sheet iron without adhering oxide. The oxidation of the surface of the metal, the solution of iron oxide in the flux, the presence of different degrees of oxidation of dissolved iron, and the formation of crystals of Fe_3O_4 were clearly ascertained. The possibility of using white enamels can be determined. A study of mixes fritted on cast iron by Salmang and his collaborators verified the importance of the softening interval of these mixes and gave information on the procedure for increasing this interval. The function of nickel and cobalt oxides was elucidated by Dietzel who made use of the results obtained by King. These oxides, dissolved in the flux, are reduced by iron and precipitated in the metallic state, while the iron goes into solution. The cobalt and the cast iron form short-circuited galvanic elements which corrode the surface of the cast iron strongly. It is essential to corrode the cast iron and fuse the enamel simultaneously. The results obtained, concerning the composition of the mix, the time and temperature of firing, and the fineness of grinding necessary, are usable in industry. Only those adhering oxides can be taken into account which are reduced by the iron, *i.e.*, which have an electromotive force higher than that of iron. The researches are not encouraging for the realization of a white enamel. A good adherence, moreover, is acquired only by a strong dissolving of the cast iron in the enamel, hence, the inevitable coloration by iron oxide and the adhering oxide; as to why enamels with a lower coefficient of expansion than that of iron can nevertheless adhere, Dietzel ascertained that the dissolving of iron oxide in the enamel increases the expansion. The layer of enamel next to the cast iron is saturated with Fe_3O_4; its coefficient is 380×10^{-7} while that of iron is 400×10^{-7}. The successive layers of enamel contain less and less iron and the coefficient diminishes progressively until 340×10^{-7}, which practically coincides with that of the covering enamel. During cooling, the outside layers of enamel are compressed. In the opposite case there would be cracking. If the compression were too great, the enamel would burst. For pieces that are bent greatly, the differences in expansion of metal and enamel must be less. For cooking utensils the enamel on the inside must have a low coefficient of expansion, for these objects are often hotter on the inside. It is important to study expansion between 0 and 100°. M.V.C.

Sheet-enamel practice: fishscales. HANS MELZER. *Glashütte*, **66** [7] 107–109 (1936).—Various present-day theories dealing with the formation of fishscales are briefly discussed. Fishscales originate in the enamel, not in the sheet iron. Examples from practice are given. M.V.C.

Solubility of enamel of cooking vessels. B. WILLBERG AND H. CAJANDER. *Z. Untersuch. Lebensmittel*, **69**, 591–94 (1935); *Brit. Chem. Abs.-B*, **54** [39] 850 (1935).—The vessels were boiled with 4% aqueous AcOH for 3 periods of 2 hr., and the total dissolved substances, B_2O_3, and F in the first and third extracts were determined. The results of the boiling tests and the composition of the enamel of six brands of vessels are tabulated.

Suggestions for enamels. VIELHABER. *Emailwaren-Ind.*, **13** [3] 19–20 (1936).—The enameling of wrought iron and iron pipes and enamels for them are briefly discussed. M.V.C.

Temperature of enamel slips. VIELHABER. *Emailwaren.-Ind.*, **12** [52] 420–21 (1935).—The heating of enamel slips during grinding is discussed, and the researches of Noble and Lindsey (*Jour. Amer. Ceram. Soc.*, **18** [10] 308–14 (1935)) are analyzed. M.V.C.

Testing the chemical resistance of enamel for kitchen ware. WALTER KERSTAN. *Emailwaren-Ind.*, **13** [8] 59–66; [9] 71–74 (1936).—The advantages of classifying enamels are discussed. Various proposals and research methods used to determine acid stability of enamels are explained. Kitchen ware and apparatus are described. The chemical resistivity of a series of enamels was ascertained. Tables and curves are plotted, showing the effect of (*a*) testing acids, (*b*) salt solutions, (*c*) duration of melting, (*d*) grinding fineness, (*e*) electrolytes, (*f*) opacifiers, (*g*) pigments, (*h*) suspending agents, (*i*) firing time, (*j*) firing temperature, and (*k*) muffle atmosphere. On the basis of numerical values obtained, K. shows how difficult it is to determine or classify the chemical resistivity of enamels with present-day testing methods. The assumption that the amount of

dissolved enamel or the loss in weight of an enamel after one treatment is a measure of chemical resistivity is groundless. The experiments made by K. show plainly that one boiling is insufficient. During the first boiling the protective effect of acid-stable constituents continues, but these constituents are dissolved during the second boiling, and the solubility increases irregularly. The manufacturing method has a great effect. The valuation of an enamel from its loss in weight is not a criterion for a practical valuation of its chemical resistance. M.V.C.

Testing enameled kitchen ware for acid stability. ERNST RICKMAN. *Emailwaren-Ind.*, **13** [7] 51–56 (1936).—Various methods used to determine the acid stability of enameled kitchen ware are analyzed, and their inadequacy is pointed out. M.V.C.

Titanium dioxide. VIELHABER. *Emailwaren-Ind.*, **12** [52] 419–20 (1935).—The extraction of titanium from various minerals and its properties are discussed. Titanium dioxide in the form of rutile is used in ceramic glazes chiefly for mat crystal glazes. Its other use is in acid-stable enamels. Up to 8% TiO_2 is used in this enamel. It has the same effect as silica in enamels although it promotes its melting. The yellow coloring produced by titanium is destroyed by a 2% addition of sodium fluosilicate. M.V.C.

PATENTS

Acidproof enamel glaze. MASAICHI MORI. Japan. 113,652, Dec. 11, 1935; *Chem. Abs.*, **30**, 3612 (1936). Talc, serpentine, asbestos, or a mixture of these is added to ordinary glaze. *E.g.*, a mixture of talc (or serpentine) 10, borax 16, feldspar 36, silica 32, niter 3, soda ash 3, and cryolite 10 parts is used. The glaze adheres to iron without cracking and is resistant to mineral and organic acids.

Coating metals. JAMES HARVEY GRAVELL. Fr. 783,250, July 10, 1935; *Chem. Abs.*, **29**, 7833 (1935). Metals, particularly Fe, Ni, Zn, Cd, and their alloys are treated in a bath which contains phosphate anions and metal cations, particularly those of Fe, Zn, Cd, Ca, Al, Ni, Co, Mn, separately or in combination, and in such manner that the objects are used as electrodes of a current which changes its direction. The bath may also contain depolarizers such as nitrates or nitrites.

Crystalline decoration for porcelain and porcelain enameled articles. J. M. SEASHOLTZ (J. M. Seasholtz and Sons, Inc.). U. S. 2,043,449, June 9, 1936 (Oct. 18, 1934).

Enamel. FIRMITANA METALLKERAMIK G. M. B. H. Ger. 619,000, Sept. 23, 1935 (Cl. 48*c*. 1); *Chem. Abs.*, **30**, 1199 (1936). Enameled objects of large area are obtained by enameling sections in a muffle furnace, joining the sections by welding, etc., cleaning the joinings or seams with sand, covering them with enamel powder, and firing with a portable heater.

Enamel. IGNAZ KREIDL. Ger. 613,587, May 21, 1935 (Cl. 48*c*. 2.02); *Chem. Abs.*, **29**, 6386 (1935). An enamel slip capable of storage consists of a mixture of clay, enamel, or flux and a substance such as benzidine which will give off gas bubbles to produce the necessary turbidity on firing.

Enamel. VEREINIGTE CHEMISCHE FABRIKEN KREIDL, HELLER & CO. Ger. 616,534, July 31, 1935 (Cl. 48*c*. 2.02); *Chem. Abs.*, **30**, 593 (1936). A turbidity-producing agent for enamel is obtained by fusing $ZrSiO_4$ with an equimolecular amount of CaO, SrO, BaO, MgO, or ZnO, and a flux and grinding the cooled product. A readily fusible glass may be used as flux.

Enameled steel. JOSEPH C. ECKEL (American Sheet & Tin Plate Co.). Can. 355,018, Dec. 31, 1935; *Chem. Abs.*, **30**, 2343 (1936). A sheet of steel having less than 0.12% C is cold-rolled, heat-treated to produce ductility, coated with a vitreous enamel, and fired. The product is free from boiling defects.

Enameling. WALTER BECKER. Ger. 618,613, Sept. 12, 1935 (Cl. 48*c*. 3); *Chem. Abs.*, **30**, 1200 (1936). Ornaments, etc., are coated with a colorless or colored enamel flux and heated. The heating is continued after the flux begins to melt and flow, till it begins to crack and form an ornamental pattern. Ag may be treated in this manner.

Enameling. ALEXANDER KREIDL. Ger. 618,612, Sept. 12, 1935 (Cl. 48*c*. 1); *Chem. Abs.*, **30**, 1200 (1936). A process for enameling Fe or steel without using a ground enamel consists in coating the metal with a layer comprising a flux and a spinel-forming metal monoxide or sesquioxide, or a metal compound forming these when heated, heating the layer to glowing in an atmosphere poor in O or with exclusion of air, cooling, applying the enamel, and reheating. The flux may be B_2O_3 or fluorspar and the oxide may be FeO or Fe_3O_4.

Enameling iron. PHILIPP EYER. Ger. 613,293, May 16, 1935 (Cl. 48*c*. 2.02); *Chem. Abs.*, **29**, 5620 (1935). As an opacifying agent for use in producing white ground enamel coatings on iron, use is made of an antimonate of Zn or of a product obtained by heating ZnO with Sb_2O_3. Preferably, the oxides are heated to 700 to 1300° with the addition of an oxidizing agent, *e.g.*, an alkali nitrate, and a refractory diluent, *e.g.*, clay or feldspar. A typical opacifying agent is prepared by heating to 700 to 800° a mixture of Sb_2O_3 20, ZnO 43, $NaNO_3$ 13, and clay 24 parts. A specified enamel comprises borax 35, quartz 20, feldspar 28, soda 6, $NaNO_3$ 4, CaF_2 7, Sb_2O_3 5, and ZrO_2 5 parts, milled with the opacifying agent 3, quartz 8, and clay 10%. The enamel is applied as an aqueous suspension in the usual way and fired at about 850°.

Enameling iron. PHILIPP EYER. Ger. 614,220, June 4, 1935 (Cl. 48*c*. 2.02); *Chem. Abs.*, **29**, 6010–11 (1935). Clear adherent ground enamels for iron are made by fusing an ordinary ground enamel composition with both Sb_2O_3 and ZrO_2 or substances which yield these oxides. A specified enamel comprises borax 35, quartz 20, feldspar 28, soda 6, $NaNO_3$ 4, CaF_2 7, Na antimonate 5, and ZrO_2 5 parts.

Enameling iron. ALEXANDER KREIDL. Austrian 144,027, Dec. 27, 1935 (Cl. 48*c*.); *Chem. Abs.*, **30**, 2721 (1936). Methods are described for producing on Fe, before it is enameled, a coating of an oxide of Fe, Ni, Co, or Mn, which promotes the adhesion of the enamel. The Fe is first heated to about 300°, to decompose greasy or oily impurities, and then, without pickling, treated with an aqueous sludge of an oxide or salt of Fe, Co, Ni, or Mn which does not evolve O when heated. The Fe is then heated to 750 to 800° in a nonoxidizing or reducing atmosphere, whereby the desired oxide coating is deposited. The aqueous sludge applied to the Fe may contain a nonvolatile acid, *e.g.*, H_3BO_3, capable of combining with or dissolving in the enamel subsequently applied.

Enameling iron. IGNAZ KREIDL. Fr. 45,279, July 22, 1935; *Chem. Abs.*, **30**, 2721 (1936). Addition to 731,233 (*Ceram. Abs.*, **12** [5] 184 (1933)). See Brit. 421,171 (*ibid.*, **14** [4] 89 (1935)).

Glazed refrigerating cabinets for foodstuffs. E. FREYTAG. Brit. 446,801, May 20, 1936 (Sept. 19, 1934).

Production of enamelware. J. E. ROSENBERG (O. Hommel Co.). U. S. 2,043,559, June 9, 1936 (June 3, 1935). The method of forming upon and bonding securely to the surface of an article of iron a coating of glass free from blue cobalt coloration comprises fusing immediately upon the surface of the iron a layer of glass which in fused condition contains an iron erosive agent in addition to the usual glass components, which agent makes the glass in fused condition erosive of the iron, and also a compound of a metal less electropositive than cobalt and capable of being replaced by iron in the compound, the compound being present in an amount sufficient to plate its metal upon the surface of the iron but not sufficient to form a continuous plating, whereby the iron is discontinuously protected from erosion by the glass, and the glass pits the iron and interlocks therewith upon cooling.

Roller apparatus for dry-cooling fused enamels. FIRMITANA METALLKERAMIK G. M. B. H. Ger. 620,271, Oct. 17, 1935 (Cl. 48*c*. 1); *Chem. Abs.*, **30**, 834 (1936).

Vitreous-enamel compositions or frits for the production of signs, decorations, etc., by stencilling. M. M. SUR. Brit. 446,970 and 447,029, May 20, 1936 (Nov. 6, 1934).

White enamel base. V. F. HAUSMAN AND E. V. KUKLIN. Russ. 35,522, March 31, 1934; *Chem. Abs.*, **29**, 8272 (1935). Into the batch is introduced apatite with a P_2O_5 content of at least 35%. The fusion is carried out at 1350 to 1400°.

White enamel and glaze. IGNAZ KREIDL. Ger. 610,995, March 20, 1935(Cl. 48*c*. 2.02); *Chem. Abs.*, **29**, 6010 (1935). The enamel and glaze are formed without the use of inorganic compounds such as metal oxides, silicates, phosphates, carbonates, etc., as turbidity agents. The turbidity is produced by minute gas bubbles formed by the decomposition of added organic-inorganic substances in the enamel or glaze during firing. Examples of such substances added to the enamel to produce fine bubbles at the firing temperature are HCO_2H, $(CO_2H)_2$, or their salts or analogs. Oxidizing agents may also be added to prevent discoloration or deposition of C by excessive decomposition.

Glass

Absorption of ultra-violet radiations by optician's glasses. C. BEDEL AND P. GESTEAU. *Jour. Pharm. Chim.*, [8] **22**, 193–204 (1935); *Brit. Chem. Abs.-B*, **54** [45] 992 (1935).—Spectrographic examination shows that the color of spectacle lenses gives no indication of their ultra-violet absorptive power. A simple apparatus is described which indicates the ultra-violet transmission on a fluorescent screen.

Application of theories of glass constitution to some special properties of enamels. FRIEDRICH HEIMES. *Sprechsaal*, **69** [7] 87 (1936); translated in *Glass*, **13** [4] 162–63 (1936).—A fundamental study of glasses which are applied either as enamels to metals or as glazes to nonmetallics is given. The problems encountered in making glass are much the same as those encountered in glazes and enamels, but the methods of solving them are necessarily different. Methods of removing absorbed gases from the glasses are discussed in detail. The lithium and fluorine ions when added to glass act as mineralizers and encourage the formation of crystals which in turn release the absorbed gases. M.C.S.

Bottle glass. V. F. JUFEREV AND V. P. USPENSKI. *Trudui Inst. Khim. Tekh. Ivanovo*, pp. 101–109 (1935); *Brit. Chem. Abs.-B*, **55** [3] 59 (1936).—The possibilities of applying natural silicates, alkaline waste products of the chemical industry, and Na_2SO_4 to the production of bottle glass are discussed.

Calculation of the melting point of glass on the basis of its chemical composition. V. F. JUFEREV. *Trudui Inst. Khim. Tekh. Ivanovo*, pp. 95–97 (1935); *Brit. Chem. Abs.-B*, **55** [3] 59 (1936).—The melting point is given by $T = 1700° + 435a + 370b + 2825k + 3000k^2$, where k represents gram-molecules % of $Na_2O + K_2O + MgO + CaO + Fe_2O_3$, $a = [Al_2O_3] - [FeO]$, and $b = [CaO] + [MgO] - [K_2O]$.

Constitution of glasses. ERNST JENCKEL. *Z. Elektrochem.*, **41** [7] 211–15 (1935).—If no compounds exist in glasses the properties of binary glasses should vary linearly with their composition. A maximum, minimum, or point of inflection in a plot of change of physical properties with composition is indicative of the formation or dissociation of compounds. Those properties chosen for study were temperature of the transformation interval, the specific volume, coefficient of expansion, and the reciprocal, n. Data for these properties from various sources were plotted against composition of the following binary glasses: sodium silicate-SiO_2, B_2O_3-borax, B_2O_3-BaO, B_2O_3-PbO, B_2O_3-SiO_2, B_2O_3-sodium silicate, B_2O_3-barium borate. In most cases there were indications of compound formation. E.J.V.

Corrosion of crucibles for glassmaking; corrosion experiments on barium crown glass. M. WATATANI. *Repts. Imp. Ind. Research Inst.*, **15** [2] 1–24 (1934); *Brit. Chem. Abs.-B*, **54** [39] 849 (1935).—The corrosion-resisting properties of various materials toward Ba crown glass were studied. Diaspore gave the best results.

Course in glassmaking. D. R. *Verre & Silicates Ind.*, **7** [10] 119–21 (1936).—Purified and cooled gas is more rational for heating than crude gas, the quantity necessary for heating being scarcely more than that of crude gas (4 to 6%). Because of its regularity of heating, constant pressure, ease of control, and higher heat efficiency, any type of gas heating is a great improvement over former methods of heating. See *Ceram. Abs.*, **15** [7] 201 (1936). M.V.C.

Drawing of glass panes. M. G. CHERNYAK. *Keram. i Steklo*, **12** [2] 13–16 (1936).—Methods of drawing glass panes used in the U.S. (Libbey-Owens and Pittsburgh methods) are described. M.V.C.

Effect of frequency of impressed electromotive force

upon the power loss and dielectric constant of various glasses. LOUISE S. MCDOWELL, PERSIS BULLARD, AND MARIAN E. WHITNEY. Read before New England Section, Amer. Phys. Soc., Williams College, Oct. 13, 1934; abstracted in *Phys. Rev.*, **46**, 939 (1934).—Power factor, power loss per unit applied potential difference, and dielectric constant for several glasses at room temperature, with variation in frequency from 60 to 14,000 cycles/sec. and from 100 to 6000 kc./sec. were studied. Data are given for five of the six glasses previously investigated by McDowell and Begeman. At frequencies above about 500 kc. the power loss in most glasses is found to increase with frequency too rapidly to fit the equation, $P/E^2 = C\omega \tan = \text{constant} \times f^n$, previously found. Results are compared with those of other investigators, and the possibility that the deviation may be due to errors in the method is discussed. J.L.G.

Evolution of the glass industry. P. GILARD. *Verre & Silicates Ind.*, **7** [9] 101–103; [10] 113–15 (1936).—The development of glassmaking is briefly traced from its earliest known origin to present achievements and future possibilities of the glass industry. M.V.C.

Gaseous inclusions in glass; determination of their nature. H. SCHILLING. *Chem.-Ztg.*, **60**, 149 (1936); *Brit. Chem. Abs.-B*, **55** [15] 319 (1936).—Inclusions are caused by too low a temperature (bubbles are on the surface only and are retained by surface tension) or too high a temperature of the melt (distillation of free alkali), too fine a state of division of the mixture (trapped air forms bubbles too small to coalesce), or SO_2 from added sulfate. The faulty glass is powdered under boiled H_2O and the evolved gas is examined; alkali is determined by grinding under dilute H_2SO_4, filtration, and evaporation of the filtrate.

Glass composition and glass batches. L. SPRINGER. *Glashütte*, **66** [2] 29–31 (1936).—The calculation of glass composition from an ordinary glass batch is not difficult. The factors which must be taken into consideration are as follows: (1) the varied water content of the different constituents, especially potash and the moisture content of sand. (2) In the case of a raw material having several constituents, such as borax or feldspar, the amount of the separate constituents is then calculated; *e.g.*, for borax, the amounts of natrium and boric acid, and for feldspar, the amounts of potassium, alumina, and silica. (3) In the determination of pigments, opacifiers, and refiners there are problems, *e.g.*, whether arsenic is introduced in pieces or powder, and under what conditions the glass is melted. (4) The determination of fluor-containing opacifiers, such as fluorspar, cryolite, and sodium fluosilicate, is quite difficult, as the major part of these materials dissolves in glass without disintegration and a part of the fluorine gases volatilizes. There are no exact data, however, because much depends on the temperature and duration of melting. (5) In impure pigments it is difficult to calculate the amount of impurities introduced and the amount which volatilizes. (6) The amount of grog dissolved by glass is little known. (7) Finally, there is a direct volatilization of some raw materials. In calculating the batch composition from a glass composition there are also a series of factors which must be considered: (*a*) the volatilization and dusting of separate raw materials; (*b*) whether Na_2O was introduced as soda or Glauber salt; (*c*) how alumina was introduced; and (*d*) the question of whether the batch should be given for 100 kg. glass or 100 kg. sand should be elucidated. M.V.C.

Glass of the Greeks and Romans. D. B. HARDEN. *Greece & Rome*, **3**, 140–49 (1934); *Jour. Soc. Glass Tech.*, **20** [78] 159A (1936).—At the beginning of the Roman Imperial period three processes of vase-making were in vogue. Sand-core and mold-pressing methods were used, the latter especially for shallow dishes, but gradually freely blown ware superseded both methods. Blown glass vessels were decorated by one of three methods, *viz.*, tooling the glass while still hot, engraving the cold glass, and applying drawn glass to the vessel while both were hot. Examples of each type are shown by photographs.

Glues and cements for glass. OTTO HERFURTH. *Diamant*, **57** [25] 295–96; [26] 306–307; [27] 319; [28] 329–31; [30] 356–57; [31] 365–67; [33] 390–91; [35] 413–14 (1935).—The compositions and properties of a series of glues and cements are analyzed. Directions for their use are given. See *Ceram. Abs.*, **15** [2] 59 (1936). M.V.C.

Knowledge and methods in sheet and plate glass manufacture. WALTER OBST. *Diamant*, **57** [36] 426 (1936).—German and foreign (chiefly American) patents dealing with (1) the production of sheet glass, (2) its hardening, (3) production of glass free from iron, and (4) production of coating for mirrors are briefly discussed. M.V.C.

Manipulator for glassblowing. V. COLLIER, JR. *Ind. Eng. Chem., Anal. Ed.*, **8** [3] 208 (1936).—A manipulator having extreme flexibility and a wide range of adjustment for use in glassblowing is described and illustrated. F.G.H.

Manufacture of mirrors for astronomical instruments stiffened by a cell structure. N. G. PONOMAREV. *Z. Instrumentenkunde*, **55** [7] 311–15 (1935).—Instead of casting a heavy, solid mass of glass for a telescope reflector, the advantages of a casting that is lighter and stiffer because of a ribbed structure on its back are described. Using a glass of low expansion, deformation due to temperature changes can be largely reduced, and because of the much lighter weight the movable part of the telescope becomes simpler. Suggestions as to the method of manufacture are discussed. M.H.

Mechanical properties of glass. L. LONGCHAMBON. *Compt. rend.*, **200**, 1381–83 (1934).—The impact strength of a glass was measured, not by the usual pendulum method, but by the vertical drop of a steel sphere in order to be independent of the size and shape of the specimen. For a certain height of the drop the glass breaks suddenly on the contact circle of the sphere. For greater heights the disk of glass broken out of the specimen by the sphere buries itself in the mass below. Results of the impact-resistance test are given for different kinds of glass. M.H.

Mechanical tests for safety glass. H. G. BODENBENDER. *Chem.-Ztg.*, **59**, 1022–24 (1935); *Brit. Chem. Abs.-B*, **55** [7] 146 (1936).—Balls of varying weight are dropped from a height of 2 m. upon the center of the sample at temperatures of 0°, 20°, and 40°. The appearance of the result is noted and the splinters are weighed. With increasing weight the following are successively observed: injury to the intermediate layer, radial as well as concentric cracking, and complete penetration with formation of a

large quantity of splinters. By this means glass from different sources may be compared.

Metallic luster colors and iridescent effects on glass. W. H. *Diamant*, **57** [34] 402 (1935).—Directions are given for obtaining various luster effects and iridescent glass. M.V.C.

Modern views on the structure of glass. H. EBERT AND S. ERK. *Glas & App.*, **16** [16] 147–48; [17] 157–58 (1935).—Modern contributions to explain the nature of glass are reviewed. As the ordered molecular state is the most stable, glass which is an irregular condition of molecules should, after some time, show an ordered state (devitrification). Investigations of old glasses (4000 to 6000 years old), however, seem to prove that, at least at ordinary temperatures, this age is not sufficient for the glass to become crystallized so that a certain stability of the vitreous state must be assumed. Eight references. M.H.

Nature of electrical conductivity of borate glasses free of alkalis. R. L. MÜLLER AND B. I. MARKIN. *Zhur. Fiz. Khim.*, **5** [9] 1272–77 (1935).—To obtain comparable data on the distribution of potentials in substances possessing different electrical conductivities, their investigation must be conducted at different temperatures corresponding to their equal specific electrical conductivities. Such investigations were undertaken with glasslike sodium borates. The results give no basis for admitting the existence of electronic conductivity of glasses poor in alkalis. See *Ceram. Abs.*, **15** [4] 118 (1936). P.B. & E.S.

Nomenclature and classification of optical glasses. R. MORETTI. *Centro Studi Ceram.*, **2** [5] 58–59 (1935).—In the classifications of barium-crown and flint glasses which are given, subdivisions are made according to the density, but there is great diversity and some contradiction among manufacturer's classifications. Zschimmer's division of glasses into eight groups, indicating the properties of different glasses as a function of their composition, is also given. See *Ceram. Abs.*, **15** [4] 117 (1936). M.V.C.

P.A.K. glassware machine. I. N. POPOV. *Keram. i Steklo*, **10** [6] 19–20 (1934).—A brief review is given of the manufacture of glass jars for preserves at the Bakinskii Glassworks with a P.A.K. machine. See "Work—" *Ceram. Abs.*, **14** [11] 276 (1935). M.V.C.

Preparation of glasses of equal coefficients of expansion. V. P. USPENSKI. *Trudui Inst. Khim. Tekh. Ivanovo*, pp. 98–100 (1935); *Brit. Chem. Abs.-B*, **55** [3] 59 (1936).—The formula $x = k(3x_1 - 3x_2)$ is given, in which x represents the percentage of Na_2O which should be added to equalize the coefficients of expansion, $3x_1$ and $3x_2$, of two glasses, and $k = 0.078$ for Na-glass and 0.0866 for K-glass.

Principles of construction and rational selection of feeders for automatic production of hollow glassware. YA. A. SHKOLNIKOV. *Keram. i Steklo*, **12** [1] 15–19 (1936).—Results obtained from testing feeders developed by the Institute of Glass confirmed the correctness of basic principles which were applied in their construction. The principles of construction and calculations have a general character and may be used in the construction of feeders of other systems. The results showed that (1) the drop obtained is thermally uniform; (2) the shape of the drop is constant and symmetrical, no distortion of the shape of drops from irregular temperature distribution being observed; and (3) the work of the feeder as to the weight of drops is satisfactory; the variation in weight did not exceed 1 to 2%. M.V.C.

Rapid method of etching glassware. EGON ARNOT. *Sprechsaal*, **69** [6] 75–76 (1936).—The etching bath consists of a solution of 2 parts by weight of hydrofluoric acid, 4 parts ammonium fluoride, and 1 part crystallized soda. Directions for preparing the solution and procedure are outlined. M.V.C.

Rare earths and their use in coloring and decolorizing glass. J. LÖFFLER. *Glashütte*, **66** [4] 63 (1936); translated in *Glass*, **13** [3] 100 (1936).—The chief source of many of the rare minerals is the monazite sand which occurs rather extensively in India and Brazil. The sand is a complex mixture of the phosphates of cerium, lanthanum, neodymium, praseodymium, and samarium with minor amounts of thorium and ytterbium. Neodymium oxide imparts to the glass a blue color with a reddish tinge, and praseodymium oxide imparts a color which varies from yellow in thin sections to green in thick sections; cerium oxide, yielding a reddish-yellow color, is not a very powerful colorant. Cerium dioxide is an effective chemical decolorizer. M.C.S. + M.V.C.

Romano-Syrian glasses with mold-blown inscriptions. D. B. HARDEN. *Jour. Roman Studies*, **25**, 163–86 (1935); *Jour. Soc. Glass Tech.*, **20** [78] 159A (1936).

Routine determination of boron in glass. FRANCIS W. GLAZE AND A. N. FINN. *Jour. Research Nat. Bur. Stand.*, **16** [5] 421–29 (1936); R. P. 882. Price 5¢.—A method for the routine determination of boric oxide in glass, based on the "partition" of boric acid between water and ether in the presence of hydrochloric acid and ethanol has been developed. A slightly acid solution of the fusion of the glass is shaken with ether and ethanol, and the boric acid in the ether layer is titrated. The partition coefficient is 0.403 at 25 ± 2°C. The advantages of this method are its speed and simplicity without material sacrifice of accuracy. Boric acid between 0.7 and 16% can be readily and accurately determined. Lime, magnesia, alumina, soda, iron, and arsenic, in amounts likely to be found in glass, do not interfere. Barium, fluorine, and abnormally large amounts of iron interfere slightly. Zinc interferes seriously. R.A.H.

Scientific work done by the Institute of Glass. A. A. ANTONOV AND I. I. BEN. *Keram. i Steklo*, **12** [2] 9–12 (1936).—A résumé of past and current scientific work done in the field of glassmelting by the Institute of Glass is given. M.V.C.

Snake-thread glasses found in the East. D. B. HARDEN. *Jour. Roman Studies*, **24** [Part I] 50–55 (1934); *Jour. Soc. Glass Tech.*, **20** [78] A159 (1936).—Snake-thread glasses were produced from the last quarter of the 2d Century to the 4th Century A.D., probably largely in Cologne, where they had been introduced by migrant workers from Alexandria and Syria. Such glasses from the Eastern Roman provinces are rare, and known examples are listed.

Storing glassware. ANON. *Glashütte*, **66** [8] 126–29 (1936).—Various ways of safely packing and storing less stable glasses to prevent their deterioration are discussed, and means of cleaning the affected surfaces of badly stored glasses are enumerated. M.V.C.

Strength of glass. T. ZIENER. *Chem.-Ztg.*, **59**, 884–85

(1935); *Brit. Chem. Abs.-B*, **54** [51] 1142 (1935).—Surface defects in glass decrease its strength. They are removed by fire-polishing or polish-etching. The weakening effect of scratching, *e.g.*, with a file, gradually diminishes or "heals" with time. The effects of cooling strains in solid and hollow glass with reference to cracking and annealing are discussed. Sterilization of vessels may be carried out in dry heat at 180° or in steam at 120°, whereby strain conditions in the glass are more readily relieved. Metal must always be sealed into the glass and not *vice versa*.

Surface tension of molten glass. W. B. Pietenpol. *Physics*, **7** [1] 26–31 (1936).—The surface tensions of a number of different glasses have been determined by a new method, "the bulb method," which is similar to the soap-bubble experiment in which the excess of pressure within the bubble can be balanced against a small head of liquid in a manometer. The weight of the glass bulb is taken into consideration. The method is applicable to a temperature range of approximately 200°C above the glass annealing point. The variation of surface tension with temperature changes over the upper range investigated is found to be of the order of 0.04 dyne/cm./°C. The magnitude of the surface tension for this range varies from 230 to 360 dynes/cm., depending upon the kind of glass. A survey of previous results on surface tension discloses values of widely different magnitudes. One group of experimenters has obtained values of the order of 150 dynes/cm., and another group, values of approximately 400 dynes/cm. The results obtained by the bulb method fall approximately midway between the values obtained by previous experimenters.

Tank or overhead flame furnaces for melting hollow glassware. Hans Baumer. *Sprechsaal*, **69** [5] 60 (1936).—The comparative advantages and disadvantages of both systems are briefly enumerated. M.V.C.

Tests for "neutral" glass for phials. M. Cini. *Boll. chim. farm.*, **74**, 805–808, 811–12, 837–40, 843 (1935); *Brit. Chem. Abs.-B*, **55** [11] 234 (1936).—Improved methods for determining the chemical behavior of so-called "neutral" glasses, used in making phials for pharmaceutical preparations, are described. The measurement of the acidity or alkalinity of such glasses is discussed.

Thermal conditions in the Fourcault channel and streakiness of glass. S. S. Berman. *Keram. i Steklo*, **12** [1] 5–11 (1936).—The conclusions are that the periodic changes of the thermal conditions, which are produced by the regenerative method of heating, are one of the causes of streaks in glass. M.V.C.

Thermal properties of ware from transparent quartz glass. F. A. Kurlyankin. *Keram. i Steklo*, **12** [2] 27–32 (1936).—Quartz glass is exceptionally resistant to rapid temperature changes. Quartz glass cups can be heated to 1100°C and quenched in water (room temperature) without injury. The thermal resistance of quartz glassware depends on its shape, size, and thickness, properties of the raw materials, and heat treatment. Thin-walled ware is the most resistant. The best thickness is from 1 to 1.2 mm. In rare cases the rapid cooling may produce strains in quartz glass, which, however, are not observed under an ordinary polariscope. These strains may eventually destroy the ware. Between 600 and 1200° quartz glass may become dull, due to a crystallization of the outer surface followed by cracking. These cracks may be filled up with particles of the material treated and cannot always be removed. When very dull, the ware shells and loses some of its weight. Crystallization of the surface is produced by sweating of mineral salts, especially sodium chloride, when the ware is touched with the fingers. Cristobalite is the crystalline phase formed on the surface. Crystallization is probably due to the formation of silicates on the glass surface. Water present on the surface promotes this process. Dullness is caused by raw materials from which the ware was produced and the temperature at which the ware is used. Glass from "polar" sand dulls less than that produced from Ural sand. Glass worked on a hydrogen flame dulls less than that worked on a blue gas flame. KCl, LiCl, $CaCl_2$, $MgCl_2$, and $FeCl_3$ produce a crystallization of the surface. Sulfuric salts of these materials have no effect on quartz glass. Dullness may be prevented by washing the ware with ether and not touching it with the bare fingers. The dull part of the surface may be removed by fusing it on "blue gas" or oxygen-hydrogen flame, and treating the crystals with hydrofluoric acid beforehand. Quartz glass is resistant to molten lead, tin, sulfur, and zinc. It is affected by antimony, silver, copper, and aluminum. Antimony and silver react with quartz glass, while copper and aluminum diffuse, producing its crystallization. M.V.C.

Viscosity of fused rocks. G. Yu. Zhukovskiĭ, M. G. Chernyak, and Z. Z. Zhitomirskaya. *Keram. i Steklo*, **12** [1] 22–27 (1936).—Diabase melts under the same conditions as an ordinary pressed glass; its refining, however, takes a much longer time. The temperature of working pure diabase is much higher than that of ordinary glass, about 1400°C. The temperature interval of working is very short. The fused mass is easily cast into shape and yields good vitreous objects. Brass can be welded with a diabase mass. When adding 10% lime (introduced in the form of chalk), viscosity is lowered and it takes 2 hr. less to refine the mass. The mass may be worked at 1230° or 1240°. The introduction of 10% MnO_2 (introduced as ore) considerably increases the rate of refining and lengthens the working interval, approaching conditions of working of ordinary glass. M.V.C.

BOOK

Glass (Vidrio). Resumen de la Historia del Vidrio. Catálogo de la Colección Alfonso Macaya. J. Gudiol Ricart and P. M. de Artiñano. Barcelona, 1935. 273 pp. + 304 illustrations. Edition of 250 copies. Davies & Co., London. Price, cloth 3 guineas, leather 6 guineas; *Jour. Soc. Glass Tech.*, **20** [78] A161 (1936).—This book consists of a short history of glass in Italy, France, Germany, England, and the Low Countries (pp. 19–41), and in the Spanish Peninsula, Catalonia, Balearic Isles, Valencia and Aragon, Andalusia and Castille (pp. 43–82), with notes on the text (pp. 83–92). A catalog follows of the exceptional glass collection of Alfonso Macaya (pp. 95–273).

PATENTS

Apparatus for:

Annealing glass objects. Corning Glass Works, Ger. 615,805, July 13, 1935 (Cl. 32*a*. 30); *Chem. Abs.*, **29**,

8269 (1935). UNITED GLASS BOTTLE MANUFACTURERS, LTD., Fr. 789,863, Nov. 7, 1935; *Chem. Abs.*, **30**, 3190 (1936).

Assembling insulated glass. J. H. FOX (Pittsburgh Plate Glass Co.). U. S. 2,042,835, June 2, 1936 (Aug. 20, 1935).

Continuous formation of undulating sheets of glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Fr. 789,484, Oct. 29, 1935; *Chem. Abs.*, **30**, 1964 (1936).

Continuous manufacture of sheet glass. FORGES ET ATELIERS DE CONSTRUCTION ÉLECTRIQUES DE JEUMONT. Fr. 781,119, May 9, 1935; *Chem. Abs.*, **29**, 6382 (1935).

Cracking scored glass sheets. M. F. ALLISON (Pittsburgh Plate Glass Co.). U. S. 2,042,819, June 2, 1936 (Oct. 6, 1933).

Drawing glass sheets. N. V. HOLLANDSCHE MIJ. VOOR DE VERVAARDIGING VAN GLAS. (H. L. Halbach, applicant in U. S.). Fr. 781,303, May 13, 1935; *Chem. Abs.*, **29**, 6381 (1935). See Brit. 425,400, March 3, 1935.

Drawing glass tubes. CORNING GLASS WORKS. Ger. 622,811, Dec. 6, 1935 (Cl. 32*a*. 23.02); *Chem. Abs.*, **30**, 3609 (1936).

Drawing sheet glass. RICHARD AMBERGER. Austrian 144,497, Jan. 25, 1936 (Cl. 32*a*.); *Chem. Abs.*, **30**, 3609 (1936).

Hardening glass sheets. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Ger. 614,682, June 15, 1935 (Cl. 32*a*. 30); *Chem. Abs.*, **29**, 8269 (1935). Addition to 564,701 (*Ceram. Abs.*, **12** [6] 224 (1933)).

Holding glass sheets during annealing. PILKINGTON BROS., LTD. Fr. 791,049, Dec. 2, 1935; *Chem. Abs.*, **30**, 3190 (1936).

Making glass plates. COMPAGNIES RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Ger. 618,701, Sept. 16, 1935 (Cl. 32*a*. 18); *Chem. Abs.*, **30**, 1196 (1936).

Making glass threads. N. V. MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Fr. 780,140, April 19, 1935; *Chem. Abs.*, **29**, 6008–6009 (1935).

Making glass tubes. PATENT-TREUHAND-GES. FÜR ELEKTRISCHE GLÜHLAMPEN M. B. H. (Wilhelm Hagen and Marcello Pirani, inventors). Ger. 624,245, Jan. 16, 1936 (Cl. 32*a*. 24.02); *Chem. Abs.*, **30**, 2719 (1936).

Making nonsplintering glass. ELEKTRO-OSMOSE (Graf Schwerin Ges.). Ger. 624,683, Jan. 25, 1936 (Cl. 39*a*. 17.50); *Chem. Abs.*, **30**, 3610 (1936). Addition to 593,016 (*Ceram. Abs.*, **13** [10] 257 (1934)).

Making objects of glass foam. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Fr. 45,417, Sept. 4, 1935; *Chem. Abs.*, **30**, 2719 (1936). See "Porous—" p. 240. The glass is drawn up into inverted molds and is used without refining, *i.e.*, while still containing air bubbles.

Making sheet glass by drawing. SIMPLEX ENGINEERING CO. Fr. 782,423, June 4, 1935; *Chem. Abs.*, **29**, 7036 (1935).

Making sheets of glass. N. V. MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN (H. E. Robinson and F. E. Eicher, applicants in U. S.). Fr. 789,590, Oct. 31, 1935; *Chem. Abs.*, **30**, 1964 (1936). PILKINGTON BROS., LTD., Fr. 787,423, Sept. 23, 1935; *Chem. Abs.*, **30**, 1196 (1936). PITTSBURGH PLATE GLASS CO., Fr. 788,454, Oct. 10, 1935; *Chem. Abs.*, **30**, 1533 (1936).

Making wired glass. SCHLESISCHE SPIEGELGLASMANUFACTUR CARL TIELSCH G. M. B. H. (Armand Lamesch, inventor). Ger. 622,526, Nov. 29, 1935 (Cl. 32*a*. 22); *Chem. Abs.*, **30**, 3610 (1936).

Silvering vacuum flasks. TOMIKICHI YAMAMOTO. Japan. 110,268, April 8, 1934; *Chem. Abs.*, **29**, 8270 (1935).

Tempering glass. LENNOX HASSAN. Fr. 781,116, May 9, 1935; *Chem. Abs.*, **29**, 6382 (1935). The jets are displaced so that the incidence of the jets on the glass changes each instant.

Tempering glass. PILKINGTON BROS., LTD. Fr. 787,964, Oct. 2, 1935; *Chem. Abs.*, **30**, 1534 (1936).

Tempering glass plates. SOC. ASSUREX. Fr. 787,132, Sept. 17, 1935; *Chem. Abs.*, **30**, 1196 (1936).

Tempering glass or steel by air or steam jets. ALBERT BOUCHE. Fr. 783,528, July 15, 1935; *Chem. Abs.*, **29**, 8269 (1935).

Tempering sheet glass. PILKINGTON BROTHERS, LTD. Ger. 618,288, Sept. 6, 1935 (Cl. 32*a*. 30); *Chem. Abs.*, **30**, 259 (1936). See Brit. 408,648.

Tempering sheets of glass. COMPAGNIE RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Fr. 784,733, July 23, 1935; *Chem. Abs.*, **30**, 590 (1936). RAYMOND MEER, Fr. 786,514, Sept. 5, 1935; *Chem. Abs.*, **30**, 831 (1936). PILKINGTON BROS., LTD., Fr. 789,268, Oct. 25, 1935; *Chem. Abs.*, **30**, 1965 (1936). SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY, Fr. 782,077, May 27, 1935; *Chem. Abs.*, **29**, 7036 (1935). Ger. 625,144, Feb. 4, 1936 (Cl. 32*a*. 30); *Chem. Abs.*, **30**, 3190 (1936).

Apparatus for and method of feeding molten glass. L. G. BATES (Hartford-Empire Co.). U. S. 2,041,222, May 19, 1936 (Jan. 18, 1935).

Application of glass protecting layer to silvered surface of mirrors. GLAS & SPIEGEL-MANUF. R. KINON. Ger. 620,192, Sept. 26, 1935 (Nov. 20, 1934); VI/32*b*, Gp. 10; *Jour. Soc. Glass Tech.*, **20** [77] A58 (1936). A strip approximately 1 mm. wide is removed from the silver layer around the edge and then an adhesive lacquer which does not affect the silver is applied and the glass protecting sheet laid over in correct register.

Blow molds for machines of conveyer belt type. K. WITTRIN AND A. RUHMANN. Ger. 615,487, June 13, 1935 (March 14, 1933); VI/32*a*, Gp. 11; *Jour. Soc. Glass Tech.*, **20** [78] A122 (1936). The mold halves are mounted in holders moving on parallel guides and are linked by a lever arm hinged to the center roller, rotation of which operates the mold opening and closing.

Bottle-molding device. FRANK L. DARLING (Anchor Cap and Closure Corp.). Can. 355,462, Jan. 21, 1936; *Chem. Abs.*, **30**, 2718 (1936). Structural details are given.

Canal cooling furnace for glassware. OTTO MAETZ AND HERMANN HEINRICHS. Ger. 616,606, Aug. 1, 1935 (Cl. 32*a*. 29); *Chem. Abs.*, **30**, 590 (1936).

Composite glass. ADOLF KÄMPFER. Fr. 790,988, Nov. 30, 1935; *Chem. Abs.*, **30**, 3191 (1936). The intermediate layer is obtained by adding 10 to 25% of emollients such as tritolyl or tributyl phosphates to a monomeric compound

such as vinyl acetate and polymerizing to a middle point or slightly beyond at a moderate temperature (40 to 80°). The temperature is then raised as quickly as possible to about 120° at which temperature the product is applied to the glass under pressure.

Continuous apparatus for drawing glass tubes. CORNING GLASS WORKS. Ger. 612,174, April 23, 1935 (Cl. 32*a*. 23.02); *Chem. Abs.*, **29**, 8269 (1935). Addition to 586,684 (*Ceram. Abs.*, **13** [8] 206 (1934)). See Brit. 397,444.

Continuous electric glass furnace. ANDERS E. A. CORNELIUS (Aktiebolaget Surte-Liljedahl). Swed. 80,130, April 17, 1934; *Chem. Abs.*, **29**, 6007 (1935). Structural features are described.

Conveyer rolls for hot glass plates. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Ger. 625,484, Feb. 10, 1936 (Cl. 32*a*. 23.01); *Chem. Abs.*, **30**, 3190 (1936).

Crucible for making optical glass. K. G. KUMANIN. Russ. 38,271, Aug. 31, 1934; *Chem. Abs.*, **30**, 1965 (1936). Construction details are given.

Cutting apparatus. E. A. ROSIN (Libbey-Owens-Ford Glass Co.). U. S. 2,042,553, June 2, 1936 (June 18, 1934).

Drawing glass tubes. S. I. KOROLEV. Russ. 35,342, March 31, 1934; *Chem. Abs.*, **30**, 2719 (1936). Construction details of a glassmelting oven are described.

Electric furnace. PAUL RICHALET. U. S. 2,041,486, May 19, 1936 (June 29, 1934). An electric furnace for treating or melting glass comprises in combination, a container for the glass mass to be treated, at least one cylindrical heating element rotatable during heating in the container about its own axis and so positioned as to be at least partly immersed in the mass, means for rotating the heating element, means carried by the heating element for stirring the mass, and electric means in the element for generating heat therein.

Electric furnace for fusing glass. OSA PARTICIPATIONS INDUSTRIELLES SOC. ANON. Fr. 786,166, Aug. 28, 1935; *Chem. Abs.*, **30**, 1195 (1936).

Electric furnaces for melting glass under a vacuum. V. E. BROMLEĬ. Russ. 34,719, Feb. 28, 1934; *Chem. Abs.*, **30**, 2718 (1936). Addition to Russ. 29,903. Construction details are given.

Electric glassmelting furnace. PATENT-TREUHAND-GES. FÜR ELEKTRISCHE GLÜHLAMPEN M. B. H. (Karl Mey, inventor). Ger. 610,531, March 12, 1935 (Cl. 32*a*. 4); *Chem. Abs.*, **29**, 6007 (1935). Ger. 624,243, Jan. 16, 1936 (Cl. 32*a*. 4); *Chem. Abs.*, **30**, 2718 (1936).

Electric insulator. WILLIAM WALKER SHAVER (Corning Glass Works). Can. 355,476, Jan. 21, 1936; *Chem. Abs.*, **30**, 2720 (1936). A porcelain insulator is glazed with an alkali-containing glass, the surface of which is stained with Cu and Ag, the colored layer having a lower alkali content than the uncolored interior portions of the glass.

Electrical luminous-discharge device for the production of green light and glass tubing for the manufacture thereof. M. FISCHER, H. FISCHER, AND M. FISCHER (trading as Glaswerk G. Fischer). Brit. 446,615, May 13, 1936 (Aug. 20, 1935).

Exerting pressure in glass press. FIRMA F. W. KUTZSCHER. Ger. 613,983, May 9, 1935 (Jan. 13, 1933); VI/32*a*, Gp. 16; *Jour. Soc. Glass Tech.*, **20** [78] A122 (1936). A glass press with a rotating table in which the pressing plunger is actuated by a rod leads through the column of the machine. A lever is connected to the plunger and also at the other end to a second lever loaded by a weight whose position can be adjusted by the screw and handwheel.

Forming screw threads on articles, *e.g.*, vials, made from tubing. J. DICHTER. Ger. 619,308, Sept. 12, 1935 (Nov. 22, 1932); VI/32*a*, Gp. 17; *Jour. Soc. Glass Tech.*, **20** [78] A124 (1936). The patent covers the use of profiling necking tongs to produce an external screw thread on a drawn down section of the tube.

Frosted lamp bulb. KÔRI ITAKURA. Japan. 113,599, Dec. 9, 1935; *Chem. Abs.*, **30**, 3610 (1936). Electric lamp bulbs are frosted by treatment at 40 to 80° with a solution of $NaHF_2$ containing NaF.

Furnace for annealing glass vessels. HUGO KNOBLAUCH. Ger. 621,667, Nov. 11, 1935 (Cl. 32*a*. 2.01); *Chem. Abs.*, **30**, 2341 (1936).

Furnace for fusing glass, etc. PAUL RICHALET. Fr. 786,133, Aug. 27, 1935; *Chem. Abs.*, **30**, 1195 (1936).

Furnace for melting and spinning glass. GEDEON VON PAZSICZKY. Swiss 172,012, Dec. 1, 1934 (Cl. 11*a*); *Chem. Abs.*, **29**, 5617 (1935).

Gas-burner system for heating glassmelting tanks. GLASWERKE RUHR A.-G. Ger. 622,234, Nov. 22, 1935 (Cl. 32*a*. 5); *Chem. Abs.*, **30**, 1533 (1936).

Glass. CORNING GLASS WORKS. Fr. 784,667, July 22, 1935; *Chem. Abs.*, **30**, 589 (1936). Glass useful for rods and mountings of electric lamps contains 2 to 3 times as much K_2O as Na_2O; the proportion of B_2O_3 is 1 to 1.1, and that of BaO, 6.5 to 7.3%. An example contains SiO_2 55 to 60, Na_2O 3 to 4, K_2O 10, PbO 19 to 21.5, BaO 6.5 to 7.3, and B_2O_3 1 to 1.1%.

Glass. GEORG DITTRICH. Ger. 614,814, June 19, 1935 (Cl. 75*d*. 17); *Chem. Abs.*, **29**, 8268 (1935). Marble-like colored glass plates for table tops, etc., are formed by coating the glass with pigment and spraying with alcohol or an alcoholic solution before it is dry. On complete drying, the pigment layer is covered with a suitable glaze coating.

Glass. I. G. FARBENIND. A.-G. (Paul Huppert and Hans Wolff, inventors). Ger. 620,347, Oct. 19, 1935(Cl. 32*b*. 2); *Chem. Abs.*, **30**, 830 (1936). In the manufacture of phosphatic glass transparent to ultra-violet rays, a salt of NH_4 is included in the melt, whereby the tendency of the glass to change in composition under the action of the rays is restrained. A phosphate of NH_4 or a salt of NH_4 having a volatile anion, *e.g.*, $(NH_4)_2CO_3$ or NH_4NO_3, may be used. The formation of blisters may be avoided by addition of an oxidizing agent, *e.g.*, an alkali nitrate or BaO_2. In one example, a mixture comprising K_2CO_3 13.77, KNO_3 6.71, $CaCO_3$ 8.93, $BaCO_3$ 3.22, $MgCO_3$ of 84.7% purity 18.53, H_3BO_4 31.04, Al_2O_3 28.8, and $(NH_4)_2HPO_4$ 48.7 parts by weight is fused in a quartz crucible to yield a glass of the composition K_2O 12.5, CaO 5, BaO 2.5, MgO 7.5, B_2O_3 17.5, Al_2O_3 28.8, and P_2O_5 26.2%. Other examples are given.

Glass. SOC. ASSUREX. Fr. 780,505, April 27, 1935; *Chem. Abs.*, **29**, 6007 (1935). An electric furnace is described for heating plates of glass before tempering. Fr. 780,518. Glass is tempered by jets of air hitting the glass at points forming equilateral triangles, the length of sides of which is determined by the thickness of the plates.

Glass. VERRERIE SOUCHON-NEUVESEL. Fr. 782,910, July 5, 1935; *Chem. Abs.*, **29**, 7036 (1935). Means for cooling the molds is described.

Glass. WÜRTTEMBERGISCHE METALLWARENFABRIK. Ger. 620,935, Oct. 30, 1935 (Cl. 32*b*. 10); *Chem. Abs.*, **30**, 1964 (1936). A method is described of decorating glass by metal in which parts of the glass are made dull or frosted and the metal rubbed therein. Metal powder mixed with colophony may be used.

Glass-annealing furnace. CORNING GLASS WORKS. Ger. 619,587, Oct. 3, 1935 (Cl. 32*a*. 29); *Chem. Abs.*, **30**, 1534 (1936). GLACERIES DE LA SAMBRE SOC. ANON. Ger. 613,985, June 3, 1935 (Cl. 32*a*. 29); *Chem. Abs.*, **29**, 8269 (1935).

Glassblowing machine. FIRMA FR. W. KUTZSCHER. Ger. 613,982, May 29, 1935 (Cl. 32*a*. 12); *Chem. Abs.*, **29**, 8269 (1935).

Glass building blocks. DAVID EDGERTON GRAY (Corning Glass Works). Can. 356,146, Feb. 25, 1936; *Chem. Abs.*, **30**, 2719 (1936). Sheets of synthetic resin are applied to opposite edges of a glass block, and the block and sheets are compressed between heated platens to soften the resin and unite it to the glass. The plates are cooled to harden the resin.

Glass furnaces. FOURS ET APPAREILS STEIN (Soc. anon.) AND CHARLES ROYER. Fr. 785,143, Aug. 2, 1935; *Chem. Abs.*, **30**, 589 (1936).

Glass grinding apparatus. J. H. GRIFFIN (Pilkington Brothers, Ltd.). U. S. 2,041,642, May 19, 1936 (Jan. 20, 1936).

Glassmaking. THOMAS F. PEARSON. Fr. 789,066 and 789,067, Oct. 22, 1935; *Chem. Abs.*, **30**, 1964 (1936). Means for supplying molten glass to the molds are described.

Glass objects. GEORGES DELACROIX AND HENRI HORAIST. Fr. 788,409, Oct. 10, 1935; *Chem. Abs.*, **30**, 1533 (1936). The primary materials used are mixed dry, then malaxed with a liquid agglutinant composed of an aqueous solution of one or more of the chemical substances entering into the composition of the glass or one or more of the primary materials, so as to obtain for the fusion, agglomerates of any form, *e.g.*, granules or briquets.

Glass permeable to ultra-violet rays. CHEMISCHE FABRIK JOH. A. BENCKISER G. M. B. H. AND FRITZ DRAISBACH. Fr.785,966, Aug. 23, 1935; *Chem. Abs.*, **30**, 590 (1936). Orthophosphates of Be, Ca, Mg, Na, or mixtures of these phosphates are used exclusively in making glass of good permeability to ultra-violet rays.

Glass shades or bowls for electric lamps. V. BÜNTE, C. BÜNTE, F. REMMLER, SR., AND F. REMMLER, JR. (trading as Bünte & Remmler Metallwarenfabrik). Brit. 447,181, May 27, 1936 (Dec. 8, 1934).

Glass tank float. FRANZ G. SCHWALBE. Can. 353,649, Oct. 22, 1935; *Chem. Abs.*, **30**, 2718 (1936). Structural details of the outlet of a glass furnace are described.

Glass tank furnaces and method of making glass therein. HARTFORD-EMPIRE CO. Brit. 447,228, May 27, 1936 (June 13, 1934).

Glass tank and method of operating. W. G. KOUPAL. (Pittsburgh Plate Glass Co.). U. S. 2,042,852, June 2, 1936 (May 29, 1934).

Glassware forming machine. R. G. ALLEN (Owens-Illinois Glass Co.), U. S. 2,041,671, May 19, 1936 (June 21, 1934). A. G. LAUCK AND D. E. GRUBE (Owens-Illinois Glass Co.). U. S. 2,041,552, May 19, 1936 (Oct. 23, 1933).

"Hardening" flat glass. F. ECKERT. Ger. 616,445, July 4, 1935 (July 17, 1933); VI/32*a*, Gp. 30; *Jour. Soc. Glass Tech.*, **20** [78] A134 (1936). The glass lying on a support is heated to a temperature above the softening point, cooled on the underface, and then on the upper, and finally quenched in cold air in known manner.

Heat-treating sheets of glass. AMERICAN SECURIT CO. Fr. 786,370, Sept. 2, 1935; *Chem. Abs.*, **30**, 1196 (1936). Supporting means for the sheets is described.

Holding suction molds of forming machines. MASCHINENGLASWERKE SALVIATI H. BULLE. Ger. 622,810, Nov. 21, 1935 (March 20, 1934); VI/32*a*, Gp. 13; *Jour. Soc. Glass Tech.*, **20** [78] A120 (1936). The halves of the suction molds are carried by a number of pivoted arms arranged one above the other.

Improving surface of rolled glass. SCHLESISCHE SPIEGELGLAS MANUFACTUR C. TIELSCH G. M. B. H. Ger. 622,467, Nov. 7, 1935 (July 11, 1933); VI/32*a*, Gp. 18; *Jour. Soc. Glass Tech.*, **20** [78] A125 (1936). After leaving the pass between the sizing rolls the upper surface is improved by the smoothing action of a further roll whose axis is set at an angle to that of the other rolls and to the direction of motion of the glass sheet.

Induction heater for fusing and refining glass. FORGES ET ATELIERS DE CONSTRUCTIONS ÉLECTRIQUES DE JEUMONT. Fr. 785,564, Aug. 13, 1935; *Chem. Abs.*, **30**, 590 (1936).

Intermittent rolling of glass from continuous tank furnace. GLACERIES DE ST. GOBAIN. Ger. 620,650, Oct. 3, 1935 (Feb. 2, 1933); VI/32*a*, Gp. 24_{III}; *Jour. Soc. Glass Tech.*, **20** [77] A44 (1936). The batch is fed in thin layers into a small melting chamber, fused, and refined by a heat source directed on to the surface, and the molten glass passes by a submerged opening to a second chamber to cool down to the working temperature before feeding to the rolling plant which rolls out sheets intermittently.

Laminated glass. EARL L. FIX AND BROOK J. DENNISON (Duplate Corp.). Can. 355,039, Dec. 31, 1935; *Chem. Abs.*, **30**, 2341 (1936). Glass sheets are cemented to the opposite sides of a sheet of ethylcellulose plastic with a solution containing H_2O, cellulose derivative similar in composition to the plastic sheet, a solvent for the cellulose derivative, and an alkali metal stannate, citrate, phosphate, arsenate, oxalate, bromide, molybdate, tungstate, aluminate, chromate, antimonate, permanganate, or vanadate.

Laminated glass. W. H. MOSS (Camille Dreyfus). Can. 356,822, March 24, 1936; *Chem. Abs.*, **30**, 3191 (1936). A sheet of glass is coated with a synthetic resin. A solution of cellulose acetate is applied in a volatile solvent to form a sheet on the resin. The solvent is permitted to evaporate and another sheet of adhesive-coated glass is placed over the cellulose acetate and then pressed at high temperature.

Laminated glass. JOHN C. ZOLA (Duplate Corp.). Can. 355,186, Jan. 7, 1936; *Chem. Abs.*, **30**, 1964 (1936). Between glass sheets is interposed a sheet of cellulose nitrate plastic containing a plasticizer (such as dimethyl, diethyl, dibutyl, or diamyl phthalate, triacetin, tritolyl phosphate or triphenyl phosphate) and a layer of cement comprising

a water-soluble cement and a high boiling solvent such as monoacetyl diglyceryl and diglyceryl ether.

Laminated glass modified light transmission. Translucent glass. Soc. anon. Italiana Balzaretti Modigliani. Ger. 614,683, May 23, 1935 (April 3, 1933); VI/32*b*, Gp. 11; *Jour. Soc. Glass Tech.*, **20** [77] A47 (1936). Glass wool was used as the interlayer, thus producing a sheet with light-dispersing and heat-insulating properties.

Laminated safety glass adhesive and method of preparing. J. D. Ryan and G. B. Watkins (Libbey-Owens-Ford Glass Co.). U. S. 2,042,485, June 2, 1936 (Aug. 27, 1934).

Leer stacking or feeding mechanisms. United Glass Bottle Manufacturers, Ltd., and E. P. Dorman. Brit. 447,602, June 4, 1936 (April 24, 1935).

Low-expansion glass for making telescope mirrors and other massive articles. Corning Glass Works. Brit. 446,733, May 20, 1936 (Feb. 19, 1935).

Machine for blowing glass articles. J. F. Rule (Owens-Illinois Glass Co.). U. S. 2,041,517, May 19, 1936 (Sept. 11, 1933).

Machine for blowing glass bulbs from tubing. British Thomson-Houston Co., Ltd. Brit. 446,885, May 20, 1936 (Dec. 12, 1934).

Machine for forming glassware. Russell G. Allen and John E. McLaughlin (Owens-Illinois Glass Co.). Can. 355,509, Jan. 21, 1936; *Chem. Abs.*, **30**, 2718 (1936). Structural details are described.

Machine for rolling plate glass. Vereinigte Vopelius'sche und Wentzel'sche Glashütten G. m. b. H. Ger. 613,984, May 31, 1935 (Cl. 32*a*. 23.01); *Chem. Abs.*, **29**, 8269 (1935).

Making vacuum vessels with internal screw necks. J. Dichter. Ger. 618,751, Aug. 29, 1935 (June 26, 1934); VI/32*a*, Gp. 27; *Jour. Soc. Glass Tech.*, **20** [78] A124 (1936). In a process for closing the neck of a vacuum vessel about a screw plug to form an internal thread in the neck, means are provided for heating, *e.g.*, electrically, the plug.

Means for feeding predetermined weights of molten glass. John Thomas Wood. Ger. 619,306, Sept. 28, 1935 (Cl. 32*a*. 5); *Chem. Abs.*, **30**, 589 (1936). This corresponds to Brit. 389,923 (*Ceram. Abs.*, **12** [7] 263 (1933)).

Means for feeding raw material to glassmelting furnaces. United Glass Bottle Manufacturers, Ltd. Ger. 616,247, July 23, 1935 (Cl. 32*a*. 5); *Chem. Abs.*, **29**, 7604 (1935). This corresponds to Brit. 406,577.

Means and method for aligning and holding lens elements. E. D. Tillyer (American Optical Co.). U. S. 2,042,565, June 2, 1936 (Dec. 16, 1933).

Means for withdrawing molten glass from furnaces. Soc. anon. d'études et de constructions d'appareils mécaniques pour la verrerie. Ger. 616,444, July 27, 1935 (Cl. 32*a*. 5); *Chem. Abs.*, **29**, 7604 (1935). This corresponds to Fr. 776,620.

Metal glass seal. Howard Scott (Westinghouse Electric & Mfg. Co.). U. S. 2,043,307, June 9, 1936 (June 14, 1934). The method of making a bubble-free joint between carbon-bearing metals and alloys and an electrical insulating substance comprises first heating the metal in the presence of hydrogen at a temperature and for a time sufficient to remove substantially all of the carbon from an appreciable depth of the surface, and then joining the insulating substance to the decarbonized surface by so heating in an oxygen-bearing atmosphere as to produce a surface oxide to which the insulating substance intimately fuses.

Metallizing glass surfaces. Compagnies réunies des glaces et verres spéciaux du Nord de la France. Fr. 790,104, Nov. 14, 1935; *Chem. Abs.*, **30**, 3191 (1936). A thin layer of metal or substance having metallic brilliance is applied in the molten state to the surface of glass. The metal may be Sb or Pb, or an alloy of low freezing point may be used.

Method and apparatus for case hardening glass sheets. G. R. Ford, Jr. (Libbey-Owens-Ford Glass Co.). U. S. 2,042,521, June 2, 1936 (April 6, 1935).

Method and apparatus for tempering glass. J. T. Littleton (Corning Glass Works). U. S. 2,042,610, June 2, 1936 (June 17, 1933).

Method of forming hollow glass articles. G. E. Rowe (Hartford-Empire Co.). U. S. 2,043,065, June 2, 1936 (Oct. 1, 1935).

Method of making ceramic objects. Otto Bartsch (Jenaer Glaswerk Schott & Gen.). U. S. 2,043,222, June 9, 1936 (July 30, 1935).

Method of making etched glassware. R. L. Wooles (A. H. Heisey & Co.). U. S. 2,043,025, June 2, 1936 (July 28, 1933). The method of etching glassware comprises applying upon a glass article an acid resist interrupted by an area of selected design to form a silhouette, dipping the article in a bath of an acid solution comprising 2 parts of water and 1 part 80% solution of hydrofluoric acid, and allowing the article to remain therein for a period ranging from 45 to 60 min. so as to produce a rough etched surface of different elevations, the portions toward the center of the silhouette design having the lowest elevations.

Method and means for feeding molten glass to glass-forming machines. United Glass Bottle Manufacturers, Ltd., and T. C. Moorshead. Brit. 447,183, May 27, 1936 (Nov. 8, 1934).

Mirrors. Duro-Ray, Ltd. Fr. 785,270, Aug. 6, 1935; *Chem. Abs.*, **30**, 590 (1936). Colloidal Ag is deposited on the surface of glass, followed by a film of Cu and finally a protective coating of Pb.

Mirrors. Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey. Fr. 786,226, Aug. 29, 1935; *Chem. Abs.*, **30**, 1197 (1936). Glass used for mirrors contains Nd oxide, whereby a warmer color is given to objects reflected in it.

Mirrors. Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey. Ger. 625,145, Feb. 4, 1936(Cl. 32*b*. 10); *Chem. Abs.*, **30**, 3191 (1936). Mirrors which give clear yellowish images are made from glass containing Nd_2O_3, the thickness of the glass (in mm.) being not more than 3 times the percentage of Nd_2O_3 in the glass.

Multicellular glass. Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey. Fr. 786,818, Sept. 10, 1935; *Chem. Abs.*, **30**, 831 (1936). A mixture of ground glass or fritted and ground vitrifiable materials with one or more powdered substances capable of liberating gases or vapors either by reaction between the added substances or with the glass or by simple decomposition is heated to the temperature at

which the glass welds together by simple contact. A mixture of C, a carbide, Carborundum, Si or Fe-Si, and a glass containing an excess of alkali or alkaline earth sulfate or a mixture of glass, white SiO_2, Na_2SO_4, and C, or a mixture of glass and talc or kieselguhr may be used.

Multi-hue (changeant) glass. GLASHÜTTENWERKE VORM. J. SCHREIBER AND NEFFEN. Ger. 615,174, June 6, 1935 (Nov. 19, 1932); *Jour. Soc. Glass Tech.*, **20** [78] A110 (1936). Addition to 581,134, VI/32*a*, Gp. 17 (*Ceram. Abs.*, **13** [7] 180 (1934)). The process outlined in the parent specification is modified in that the mass of glass is preformed by pressing a mold to produce a variation of thickness at the edge, and a second gathering of another color or composition is laid over such depressions and the whole pressed to the finished shape.

Nonsplintering glass. DEGEA A.-G. (Auerges.). Ger. 624,462, Jan. 21, 1936(Cl. 39*b*. 27); *Chem. Abs.*, **30**, 2719 (1936). Sheets of glass are joined together, or are united to sheets of celluloid or like transparent material, by means of synthetic resins prepared by condensing polyhydric alcohols with phthalic or succinic acid in the presence of a polybasic aliphatic acid of more than 4 C atoms, *e.g.*, adipic acid. The resins are used in the fused state, alone or with appropriate additions, *e.g.*, softening agents, other synthetic or natural resins, or cellulose derivatives. Processes for the manufacture of typical resins are described, and details of the use of the resins are given.

Opacifying glass. GEBR. PUTZLER GLASHÜTTENWERKE G.M.B.H. Ger. 618,029, Aug. 31, 1935(Cl. 32*b*. 6); *Chem. Abs.*, **30**, 259 (1936). An irregular opacity is produced by treating glass with an aqueous KHF_2 bath of moderate concentration, *e.g.*, 10 to 60%, to which additional HF has been added in a proportion up to 10% by volume.

Photoluminescent glass. WALDEMAR KAUFMANN, LUDWIG ECKSTEIN, AND KONRAD ROSENBERGER (I. G. Farbenindustrie A.-G.). U. S. 2,042,425, May 26, 1936 (July 16, 1935). In a glass containing tin as a metal exciting luminescence and the acid components of which contain at least 20% of P_2O_5, the glass is characterized by the fact that when excited by ultra-violet radiation of short wavelength it gives a particularly high yield of visible light.

Plastic for laminated safety glass. J. D. RYAN AND G. B. WATKINS (Libbey-Owens-Ford Glass Co.). U. S. 2,042,486, June 2, 1936 (Aug. 27, 1934).

Porous glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Fr. 781,050, May 8, 1935; *Chem. Abs.*, **29**, 6008 (1935). Porous glass of density fixed beforehand is made by heating a determined weight of glass to about 1400°, pouring the molten and vesicular mass into a mold heated to 400°, lowering the pressure in the mold so that the glass froths up and fills the mold, and maintaining the reduced pressure until the mass solidifies. The mass is removed and heated in a furnace to 600° and allowed to cool slowly.

Press for making ply-glass. ADOLF KÄMPFER AND ADOLF C. PLÖTZE. Ger. 619,943, Oct. 10, 1935 (Cl. 39*a*. 17.50); *Chem. Abs.*, **30**, 1533 (1936).

Pressing articles with internal screw thread. WHITALL-TATUM CO. Ger. 618,923, Sept. 5, 1935 (June 1, 1931); VI/32*a*, Gp. 17; *Jour. Soc. Glass Tech.*, **20** [78] A122 (1936). In a process for pressing glass in which individual screw plungers are provided to each mold unit, the plunger tips being unscrewed after pressing, the plunger withdraws only so far as to enable the tip to be unscrewed and the article lifted from the mold.

Preventing blurring of glass. FELDMUEHLE A. G. VORM. LOEB, SCHOENFELD & CO. Fr. 786,726, Sept. 9, 1935; *Chem. Abs.*, **30**, 831 (1936). The glass is coated with a layer of transparent material which will absorb water without modification, *e.g.*, viscose, casein, or gelatin.

Prevention of weathering of glass. ASAHI GARASU K. K. (Naojiro Matsuo and Hideo Tanikai, inventors). Japan. 111,397, July 2, 1935; *Chem. Abs.*, **30**, 2341 (1936). The weathering of glass is prevented by treating the surface with a volatile essential oil (such as turpentine oil or camphor oil).

Process for making indium-containing glass. W. S. MURRAY. U. S. 2,042,117, May 26, 1936 (Nov. 26, 1934). The method of producing a transparent indium sesquioxide-containing glass by fusing together a compound of indium, a compound of sulfur, silicon dioxide, sodium carbonate, and calcium carbonate is described.

Producing and spinning together glass threads. N. V. MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 615,804, June 20, 1935 (Oct. 25, 1933); VI/32*a*, Gp. 25; *Jour. Soc. Glass Tech.*, **20** [78] A109 (1936). Glass is melted in a rotating refractory chamber provided at its base with an outwardly flared aperture from the edge of which the thin layer of molten glass is flung off as a number of threads. The rotation spins these into a kind of twine, which is removed by suitable winding means after being turned by passing over a pulley into a direction perpendicular to that of the furnace axis.

Production of ampoules. J. DICHTER. Ger. 615,097, May 29, 1935 (May 22, 1930); VI/32*a*, Gp. 27; *Jour. Soc. Glass Tech.*, **20** [77] A41 (1936). Means are provided for centering the ampoules or their necks.

Production of colorless glass containing TiO_2. I. G. FARBENINDUSTRIE A.-G. Ger. 622,346, Nov. 7, 1935 (April 16, 1931); VI/32*b*, Gp. 1; *Jour. Soc. Glass Tech.*, **20** [78] A103 (1936). This patent covers the production of a glass containing 20 to 48% by weight of TiO_2 and 20 to 35% of alkali, the remainder being acid oxides, and the whole being melted at a temperature slightly above 1300°. Part or the whole of the alkali is added as nitrate in the batch.

Production of multi-hue colored glassware. W. BECKER. Ger. 620,415, Sept. 26, 1935 (May 26, 1934); VI/32*b*, Gp. 9; *Jour. Soc. Glass Tech.*, **20** [78] A110 (1936). The shape of the article and the arrangement of the colored layers upon it are such that light entering on the colored glass-air surface is reflected within the body at least twice before leaving at a point removed from that of entry.

Production of nontransparent glass. SOC. ANON. DE ST.-GOBAIN. Ger. 616,031, June 27, 1935 (March 23, 1933); VI/32*b*, Gp. 1; *Jour. Soc. Glass Tech.*, **20** [78] A103 (1936). A glass containing boric acid and carbon in addition to silica and other glass-forming materials is melted and then cooled off and worked without waiting for it to refine.

Production of quartz plates and disks. ALLGEMEINE ELECTRICITÄTS GES. Ger. 621,187, Oct. 10, 1935 (Nov. 6, 1931); VI/32*a*, Gp. 35; *Jour. Soc. Glass Tech.*, **20** [77]

A28 (1936). Previously fused quartz grains of 10 to 50 mm. diameter are used as a foundation for a mirror which is formed by melting down the tops of the grains by a locally applied source of heat.

Protective system for furnaces. LAURENCE MEHARG, J. H. KAYLOR, AND D. I. RODENBAUGH (Hazel-Atlas Glass Co.). U. S. 2,042,475, June 2, 1936 (July 26, 1934).

Roller apparatus for conveying sheet glass to cooling leers. GLACERIES DE LA SAMBRE SOC. ANON. Ger. 622,235, Nov. 23, 1935 (Cl. 32*a*. 34); *Chem. Abs.*, **30**, 1534 (1936).

Rolling plate glass. Arrangement of rolls. SCHLESISCHE SPIEGELGLAS-MANUFACTUR C. TIELSCH G.M.B.H. Ger. 620,595, Oct. 3, 1935 (Oct. 24, 1932); VI/32*a*, Gp. 18; *Jour. Soc. Glass Tech.*, **20** [77] A44 (1936). In a system of rolls in which a feeding roll driven in the same sense as the lower sizing roll is positioned before the latter, the feeding roll is driven at a higher surface speed than the sizing roll.

Safety glass. E. C. COTTET (Soc. des usines chimiques Rhône-Poulenc). U. S. 2,041,528, May 19, 1936 (Nov. 24, 1934). As a new article of manufacture, a safety glass contains an adhesive layer, one of the constituents of which is an ester of silicic acid.

Safety glass. DEUTSCHE CELLULOID-FABRIK. Fr. 785,422, Aug. 9, 1935; *Chem. Abs.*, **30**, 590 (1936). Plates of glass are coated by projection with an aqueous paste or emulsion of a polymerization product; the water is removed, and the plates of glass are brought together and joined by heat and pressure.

Safety glass. ADOLF KÄMPFER. Fr. 786,555, Sept. 5, 1935; *Chem. Abs.*, **30**, 831 (1936). Apparatus for removing solvent from the intermediate layers is described.

Safety glass. SOC. DES USINES CHIMIQUES RHÔNE-POULENC. Fr. 781,263, May 11, 1935; *Chem. Abs.*, **29**, 6383 (1935). The glass and (or) the sheet of plastic material containing cellulose derivatives are coated with one or more agents favoring adhesion, containing an organic ester of silicic acid. Thus, the sheets are assembled in a bath containing benzyl alcohol and ethyl or benzyl silicate or are coated with an acetone solution containing cellulose acetate, triacetin, and butyl silicate.

Safety glass. SOC. DES USINES CHIMIQUES RHÔNE-POULENC. Ger. 621,676, Nov. 12, 1935 (Cl. 39*b*. 27); *Chem. Abs.*, **30**, 2341 (1936). Glass plates are held together by a middle plate of plastic cellulose derivative coated with an organic ester of H_2SiO_3 as the adhesive. The Et ester of H_2SiO_3 is mentioned in examples.

Safety glass. SOC. DU VERRE TRIPLEX. Fr. 791,156, Dec. 5, 1935; *Chem. Abs.*, **30**, 3191 (1936). In the plastic cores between the layers of glass is imbedded a conducting material which serves when an electric current is passed to heat the glass to a suitable temperature to avoid the formation of "frosting" or "misting" thereon, or for heating vehicles or buildings in which the glass is used.

Safety glass. MICHIO TAKAHASHI. Japan. 110,297, April 12, 1935; *Chem. Abs.*, **29**, 8270 (1935). A mixture of cellulose derivative, *e.g.*, nitrate, and butyl acrylate or its polymerization product is used as an adhesive for two glass plates.

Selenium pigment for glass. I. I. KITAIGORODSKIĬ. Russ. 38,281, Aug. 31, 1934; *Chem. Abs.*, **30**, 1965 (1936). A Se pigment is prepared by fusing Zn or Cd selenide with sulfides of one of the above metals in the presence of reducing agents.

Sheet glass inspection apparatus. F. R. HOHMANN (Libbey-Owens-Ford Glass Co.). U. S. 2,042,526, June 2, 1936 (Sept. 1, 1932).

Silica articles. FRANZ SKAUPY. Ger. 623,138, Dec. 13, 1935(Cl. 32*a*. 35); *Chem. Abs.*, **30**, 2341 (1936). Addition to 611,098 (*Ceram. Abs.*, **14** [9] 222 (1935)). The process of Ger. 611,098, is modified by using as the starting material a glassy variety of quartz, *e.g.*, quartz which has been previously fused and powdered. The process can then be effected at a lower temperature, *e.g.*, 1000 to 1470°.

Silvering solution. GASHÔ TANIMOTO. Japan. 110,744, May 13, 1935; *Chem. Abs.*, **30**, 2341 (1936). A mixture of a $AgNO_3$ solution containing a few drops of NH_4OH, a KOH solution, and a tartaric acid and saccharin solution, exposed to sunlight or ultra-violet rays separately before mixing, is used for silvering glass plate. The Ag film is quickly produced and is resistant to heat and moisture.

Spinning of glass thread mats. CHANCE BROS. & CO., LTD., AND A. L. FORSTER. Brit. 447,566, June 4, 1936 (March 12, 1935).

System for hardening glassware by treatment with a stream of a gaseous or liquid cooling agent. HERZOGENRATHER GLASWERKE BICHEROUX & CIE. G. M. B. H. Ger. 626,078, Feb. 20, 1936 (Cl. 32*a*. 30); *Chem. Abs.*, **30**, 3609 (1936).

Timing feeder operation in relation to forming machine. WHITALL-TATUM CO. Ger. 616,558, July 4, 1935 (June 1, 1931); VI/32*a*, Gp. 15; *Jour. Soc. Glass Tech.*, **20** [78] A118 (1936). A variable speed drive is arranged to work automatically between the feeder and machine, using a friction clutch. A claw drive is fitted to the driving shaft of the forming machine which permits the latter to move forward again only when in correct time relation to the feeder operation.

Toughened glass. PILKINGTON BROS., LTD. Ger. 623,137, Nov. 28, 1935 (March 27, 1935); VI/32*a*, Gp. 30; *Jour. Soc. Glass Tech.*, **20** [78] A134 (1936). Both the heating and cooling of the glass are carried out by the action of metal in the fluid state.

Treatment of quartz articles. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Ger. 616,030, July 18, 1935 (Cl. 32*a*. 35); *Chem. Abs.*, **29**, 7606 (1935). See Fr. 752,926.

Truck for conveying pottery, glass, etc., through tunnel kilns. KURT ULBRICHT. Ger. 623,163, Dec. 14, 1935 (Cl. 80*c*. 5); *Chem. Abs.*, **30**, 2341 (1936). A method of lining the truck is described.

Two-arm suction forming machine. K. ZUMPE. Ger. 615,236, June 6, 1935 (Oct. 2, 1931); VI/32*a*, Gp. 13; *Jour. Soc. Glass Tech.*, **20** [78] A119 (1936). The machine has two parison and two blow molds, the former being carried on movable arms set at an angle to each other and so disposed in relation to the two fixed blow molds that by a pendulum-like motion in a horizontal plane the one arm is located above the gathering position while the other is above its blow mold to effect the transfer. The return swing reverses the respective positions.

Vitreous material. ALBERT W. H. WEDLOCK AND

MYCALEX (Parent) CO., LTD. Fr. 791,079, Dec. 2, 1935; *Chem. Abs.*, **30**, 3190 (1936). See Brit. 432,424.

Vitreous silica articles. IMPERIAL CHEMICAL INDUSTRIES, LTD. Ger. 623,316, Dec. 20, 1935 (Cl. 80*b*. 8.06); *Chem. Abs.*, **30**, 2342 (1936). See Brit. 402,400.

Window glass. OXELÖSUNDS JÄRNVERKS AKTIEBOLAG. Fr. 791,056, Dec. 2, 1935; *Chem. Abs.*, **30**, 3191 (1936). During the heating of the glass, the drawing mouthpieces are maintained below the surface of the glass.

Structural Clay Products

Brick that float. EDITORIAL. *Indian Eng.*, **96** [25] 487 (1934); **97** [2] 24 (1935).—A committee of experts has discovered a process whereby brick of any shape or color can be made out of a waste material (spent shale) and has also perfected means of manufacturing brick so light that they can float, so tractable that they can be cut with a saw more easily than timber, and yet so strong that they can be used for building. The Pumpherston Works of the Scottish Oil, Ltd., West Lothian, Scotland, has been organized for the commercial manufacture of these brick. A.P.S.

Brick as protection against soil erosion. HERBERT GEPP AND R. T. MCKAY. *Clay Prod. Jour. Australia*, **3** [7] 21 (1936).—The building of brick walls is advocated against erosion of every kind, whether sea, dust, or desert. British opinion quoted is that brick is preferable to natural stone for this purpose. H.H.S.

Brick strengths and statistical research methods. O. DRÖGSLER. *Mitt. staatl. tech. Versuchsamtes*, **24**, 28–34 (1935).—D. investigated the way in which strength and uniformity can be continuously checked in the manufacturing process or in course of erection of a brick structure by testing 3 or 4 pieces continually and evaluating the results statistically. It was also determined whether the bending test permits judging the compression strength of a brick. The relation between these two could be expressed by $r = xy/Nx\mu_x\mu_y$, where N is the number of tests used in the statistic, x the deviation of an individual value from the arithmetic average of bending strength, y the same for compressive strength, and μ_x and μ_y the average deviations for all bending and compressive strengths, respectively. In general, it was found that the deviations are still too great to rely absolutely on this method; it would be possible to calculate the compressive from the bending strength only if μ could be kept less than 10% of the respective average values. The application of the method is illustrated by examples. M.H.

Choice of pipe material for sewers: II-III. HUGO BRONNECK. *Clay Prod. Jour. Australia*, **3** [6] 5, 8–11; [7] 19–21 (1936).—The superiority of stoneware over other materials for sewer pipe is discussed. A sewage acidity of 0.006% has been found to damage concrete. Nitrates in water, 0.01% $NaNO_3$, are harmful to cement. The destructive action of the soil is greater on concrete than on stoneware. Attempts to protect concrete by inner linings, such as bitumen, have not succeeded. For Part I see *Ceram. Abs.*, **15** [7] 206 (1936). H.H.S.

High-lime mortar for leak-proof masonry. F. LOPTUS. *Ind. Eng. Chem.*, **27** [10] 1126–27 (1935).—High-lime mortar is discussed with respect to the following requisites of a good mortar: (1) good troweling properties; (2) impermeability: a suitable structure when hardened to resist the passage of water; (3) adhesion: the ability to bond properly to the masonry units; (4) flexibility: the ability to resist stresses due to temperature, settlement, wind, etc., without failure; and (5) minimum volume change. F.G.H.

PATENTS

Brick. JAKOB KELLER-HANHART. Swiss 172,296, Jan. 16, 1935(Cl. 8*b*.); *Chem. Abs.*, **29**, 5618 (1935). Waterproof frost-resisting brick are made by admixing Na_2HPO_4 solution to the brick clay before molding and firing. Alternatively, the brick may be sprayed with the solution before firing.

Brick. M. LOOTENS. Belg. 408,934, May 31, 1935; *Chem. Abs.*, **30**, 2719 (1936). A dry mixture of sand, cement, and hydraulic lime is wetted and compressed in a brick press. Coloring matters can be added to the mixture before the wetting.

Building brick. GEORGE WITTY. U. S. 2,043,642, June 9, 1936 (July 26, 1935). A blast-furnace slag brick consists of ground blast-furnace slag, hydraulic lime, calcium silicofluoride, calcium chloride, chrome alum, and pigments.

Ceramic products. GRANDES TUILLERIES DE NEMOURS. Fr. 788,194, Oct. 5, 1935; *Chem. Abs.*, **30**, 1534 (1936). Extra-hard ceramic products are made from sedimentary rocks and volcanic rocks, to which is added about 5% of a degreasing element such as silex or quartz or an alkaline flux. The ground ingredients are wetted, mixed, molded, and fired at about 1200°.

Molded articles containing calcium hydrosilicate. KARL I. A. EKLUND. Ger. 621,340, Nov. 5, 1935 (Cl. 80*b*. 10.01); *Chem. Abs.*, **30**, 1198 (1936). In the manufacture of tile, etc., by molding and hardening mixtures containing lime and sand, the lime is first mixed with sufficient water to slake it and then treated with steam at a higher pressure than the steam employed in the hardening process. The slaking of a part of the lime during the hardening process is thus prevented, and products of improved mechanical properties are obtained.

Molded articles containing calcium hydrosilicate. KARL I. A. EKLUND. Ger. 621,341, Nov. 5, 1935 (Cl. 80*b*. 10.01); *Chem. Abs.*, **30**, 1198 (1936). In the manufacture of pipes, plates, etc., by molding and hardening mixtures containing CaO and a siliceous material, an excess of water is used in preparing the mixture which is then molded by a centrifugal or vibrational process under such conditions that a part of the water is separated. Products of more uniform properties are thus obtained. Various details are given.

Walls, or brick, tile, slabs, etc., for use in the construction of walls. W. H. HILL. Brit. 446,815, May 20, 1936 (Aug. 15, 1935).

Waterproofing building tile, etc. I. G. FARBENIND. A.-G. (Theodor Marx, inventor). Ger. 625,385, Feb. 8, 1936 (Cl. 80*b*. 19.02); *Chem. Abs.*, **30**, 3192 (1936). The articles are treated with a solution of Al formate, preferably by immersion, and then dried.

Refractories

Coppee coking plant at Hardwick (England). EDITORIAL. *Coal Carbonization*, 2 [5] 87 (1936).—A plant built in 1934 comprising 19 Coppee underfired regenerative ovens and auxiliary equipment is described. Ovens are constructed of 95% silica brick to one course below oven soles and of 82 to 84% silica brick from there to the bottom. G.T.

Destruction phenomena in a blast-furnace shaft. M. MYRONOVICZ. *Hutnik*, No. 1, pp. 1–5 (1936); abstracted in *Referat. Silikatliteratur*, No. 2574 (1936).—Grog brick in the upper part of the shaft were destroyed chemically by the corroding effect of zinc (Polish works use ore containing zinc) and mechanically by charging. The lower part of the shaft was attacked by carbon deposition and alkali. The grog surface showed crystals of zinc and zinc oxide. M.V.C.

Determining the coefficient of expansion of coke-oven silica brick. G. V. KUKOLEV AND V. A. BRON. *Koks i Chim.*, No. 10, pp. 49–53 (1935); *Brit. Chem. Abs.-B*, 55 [13] 276 (1936).—A sample of SiO_2 brick approaching a coke-oven brick in size is heated in a special electric furnace. The expansion of the refractory is obtained by difference of the expansions of brick and brick plus furnace floor.

Increasing the heating surface of an existing hot-blast stove by means of inserts in the checkerwork. K. SKROCH. *Hutnik*, 6, 61–68 (1934); abstracted in *Stahl & Eisen*, 55 [9] 240 (1935).—Details are given of the reconstruction of a hot blast stove when the heating surface was increased by inserting "stöcker" brick into the checkerwork. M.V.C.

Insulating-refractory lined furnaces. J. G. COUTANT. *Ind. Heating*, 2 [9] 522–24 (1935).—The advantages of using heat-insulating refractories as lining material for furnaces are mainly that the useful radiant heat of the fuel remains confined within a very narrow zone near its source, the thermal losses through heat conductivity are lowered considerably, and the thermal efficiency is improved because of lower storage heat. Operating data from furnaces and constructive details are given. M.H.

Kyanite coating for tank blocks with a high grog content. V. A. RUIBNIKOV. *Keram. i Steklo*, 12 [1] 12–14 (1936).—Attempts to produce kyanite lining for the protection of refractories for glass tanks are described. The composition of the lining was 65 to 85% kyanite, 14.5 to 30% clay, 5 to 10% feldspar, and 2.5 to 5.0% sodium silicate. The tests showed that (1) the kyanite refractory lining with a low water absorption (5.9 to 9.0%), high mechanical strength (849 to 506 kg./sq. cm.), a refractoriness of 1735 to 1710°C, and an alumina content from 41.4 to 44.3% can be used successfully for coating grog brick; and (2) the alumina content can be increased provided that the clay and flux content is lowered and the temperature of firing is above 1400°. Blocks of ordinary composition containing 85% grog and 15% clay were coated by ramming, dried, and fired to 1380 or 1410°. The experiments showed that the adherence of kyanite coats to grog blocks was satisfactory. M.V.C.

Magnesite brick in the glass industry. JULIUS LAMORT. *Feuerungstechnik*, 24 [3] 40–41 (1936).—Present-day magnesite brick contain less iron than do grog brick and are superior to them in other respects. Magnesite brick used in the bottom of tank furnaces (Didier Glassworks) are durable and do not affect the color of white glass. Magnesite as a basic material should not show a great resistance to a normal acid glass melt, but when used as a protection for the tank bottom it yields good results because of its specific gravity which is much higher than that of glass so that glass does not dissolve it. Experiments in using magnesite instead of silica for burners and other places which do not come into contact with molten glass were successful inasmuch as the magnesite is more resistant to dust and alkali vapors than the silica. Magnesite for checker brick has advantages over other refractories, being alkali-resistant and especially suitable for storing up heat and exchange of heat. Experiments show the necessity of separating silica and magnesite walls by a neutral layer in glass furnaces. Tests made by the Didier Glassworks showed that corundum brick with 91% Al_2O_3 have no effect on either silica or magnesite brick. M.V.C.

Manufacture of fused magnesium oxide. S. A. SACHARUK AND G. M. VAINSTEIN. *Rept. Centr. Inst. Met.*, No. 17, pp. 40–50 (1934); *Brit. Chem. Abs.-B*, 55 [19] 406 (1936).—Pure MgO is necessary for the production of a pure fused product. On slow cooling of the molten charge, Fe_2O_3 and SiO_2 migrate toward the outer zone. Fe is present in the inner zone as FeO. A C furnace bottom reduces Fe_2O_3 to FeO and gives the MgO a greenish color.

Meeting modern demands in refractories. W. J. REES. *Brit. Clayworker*, 45 [529] 58–59 (1936).—The modern trend in silica brick, use of dead-burned dolomite in place of magnesite, the development of the sillimanite brick in recent years, the continuous tunnel kiln, and sands for foundry use are discussed. R.A.H.

Preparation of aluminium chloride from the oxide. P. P. FEDOTEEV AND A. A. TSCHISHIK. *Trudui gosudarst. Inst. Prik. Khim.*, No. 20, pp. 59–68 (1934); *Brit. Chem. Abs.-B*, 54 [39] 848 (1935).—The formation of $AlCl_3$ from kaolin is facilitated by preliminary treatment with HCl or HNO_3 (warm).

Properties of sagger mixes dependent on the modulus of the coarseness of grog. R. MAKIH. *Keram. i Steklo*, 12 [2] 33–35 (1936).—A new constant factor is obtained when taking the modulus of coarseness as a characteristic of granulometric composition of grog. This will enable the comparison of qualities of various grog mixes, being based on the study of the effect of grog with a constant composition of grog, assuming that grog of the same modulus has the same effect on the properties of the mix. By determining the optimum modulus of grog, it is possible to maintain this modulus constant by adding other fractions; in this way grog mixes of optimum standard quality may be produced (provided the raw materials are of the same composition). M.V.C.

Quenching test for refractories. ADOLF MÖSER. *Feuerungstechnik*, 24 [1] 9–10 (1936).—A method for the simultaneous determination of the resistance to abrupt changes of temperature and resistance to corrosion of various refractories, especially their permeability, is described. The results are tabulated and plotted on diagrams. M.V.C.

Refractories materials for steel works: II–IV. R.

KLESPER. *Sprechsaal*, **68** [49] 747–49; [50] 761–63; [51] 777–79 (1935).—R. discusses in detail refractory products used in steel works and requirements as to their composition, structure, manufacture, drying, and storing. For Part I see *Ceram. Abs.*, **15** [3] 95 (1936). M.V.C.

Refractory materials of highest neutrality. R. *Feuerungstechnik*, **24** [1] 12 (1936).—Chrome is used for refractory cements and as a plastic refractory for water-cooled walls and furnace floors. Among the known refractories, it possesses the highest degree of neutrality and is therefore resistant to slag attack. Its fusing temperature lies between 1900 and 2050°C. The use of plastic refractories and their properties are mentioned. M.V.C.

Refractory materials: recent investigations. A. T. GREEN. *Trans. Inst. Gas Engrs.*, **80**, 143–46 (1930–31).—A survey is given of those investigations conducted by the British Refractories Research Assn. which have a direct bearing on the gas industry. Summaries include the following papers: (1) Influence of atmosphere on the load-bearing capacities of fire brick, by H. T. S. Swallow, *Bull. Brit. Refrac. Research. Assn.*, No. 21, pp. 23–37 (*Ceram. Abs.*, **10** [1] 41 (1931)). (2) I, Effect of repeated firing on the structure and properties of lime-bonded silica brick. II, Determination of the properties of quartz, cristobalite, and tridymite. III, Determination of the reversible thermal expansion, by W. Hugill and W. J. Rees, *Bull. Brit. Refrac. Research Assn.*, No. 21, pp. 4–10 (*Ceram. Abs.*, **10** [1] 40 (1931)). (3) Effect of iron oxide and a reducing agent on the rate of inversion of quartz, by W. J. Rees and W. Hugill, *Bull. Brit. Refrac. Research. Assn.*, No. 21, pp. 17–19. (4) Note on the effect of iron oxide on the rate of quartz inversion, by W. J. Rees, *ibid.*, pp. 20–22. (5) Corrosion of refractories by glassy slags, by A. J. Dale, *Bull. Brit. Refrac. Research Assn.*, No. 22, pp. 48–68 (*Ceram. Abs.*, **7** [5] 302 (1928)). (6) Lime-bonded and clay-bonded silica brick made from calcined ganister, by W. J. Rees and W. Hugill, *Bull. Brit. Refrac. Research Assn.*, No. 21, pp. 11–16. G.H.A.

Thermal insulation of open-hearth electric steel furnaces. HANS WENTRUP. *Stahl & Eisen*, **55** [22] 590–91 (1935).—Details of thermal insulation of open-hearth and electric steel furnaces and economics achieved in the consumption of fuel, electric energy, heat loses, etc., are briefly discussed. Data are taken from the studies of S. Wohlfart and O. Ell (*Ceram. Abs.*, **15** [5] 155 (1936)). M.V.C.

Use of carbon brick. R. KLESPER. *Feuerungstechnik*, **24** [3] 44–46 (1936).—A series of German studies (published chiefly in *Stahl & Eisen*) of the properties and behavior of carbon brick in electric steel-melting furnaces and blast furnaces are analyzed. A table showing the comparative properties of grog, magnesite, silica, and carbon brick is given; the latter were found to be especially advantageous in blast furnaces. M.V.C.

Use of present-day refractories in basic open-hearth furnaces. K. RADZWIKI. *Hutnik*, **7** [9] 297–302 (1935); abstracted in *Referat. Silikatliteratur*, No. 2501 (1936).—Because the melting point of silica brick lies near the temperatures prevailing in open-hearth furnaces, the places subjected to these high temperatures are lined with special refractories, such as magnesite, chromite, chrome-magnesite, corundum, or sillimanite brick. The properties of these refractories are discussed, and experiments made with these brick ("Experiences—" *Ceram. Abs.*, **14** [8] 189 (1935)) are described. Results obtained in other steel works are analyzed. M.V.C.

BOOK

Destruction of silicon carbide brick in the temperature region from 900 to 1100°C. H. HOFMANN. Dissertation, Tech. Hochschule Braunschweig, 53 pp., 1934; abstracted in *Referat. Silikatliteratur*, No. 1742 (1936).—The study of pure silicon carbide showed that the black crystals contained the most carbon and that the dark coloring of silicon carbide is due to colloidally dissolved particles of carbon in the crystals. The purest material showed the highest specific gravity. Thermal analysis showed that silica changes into cristobalite during the destruction of SiC brick. Reactions in solid state showed that lime and iron oxide attack SiC greatly; they slag and corrode it, but do not make it friable. The chemical reciprocal action between iron oxide and silicon carbide occurs between 1000 and 1200° and that between lime and SiC at about 525°. Long heating in streams of oxygen, carbon monoxide, carbon dioxide, and steam was without effect on silicon carbide brick with the exception of the latter. Calcining in open gas flame (Bunsen, pressed air, acetylene burners) was without results. It was found that hydrogen sulfide with water promotes the destruction of silicon carbide.

Sulfur combined with O does not attack it, while that combined with hydrogen destroys SiC (including the pure SiC crystals). Thermal shock does not destroy SiC brick. The prevailing idea that oxygen destroys SiC is false. M.V.C.

PATENTS

Alumina. I. I. ISKOL'DSKIĬ. Russ. 35,180, March 31, 1934; *Chem. Abs.*, **29**, 8254 (1935). An aqueous suspension of nephelite is treated with H_2S, the mixture is allowed to settle for 1 to 3 days, the major portion of H_2S is removed by heating, and finally the SiO_2 precipitate is filtered off.

Alumina. MITSUBISHI KÔGYÔ K. K. (Kôji Ansei, inventor). Japan. 110,261, April 8, 1935; *Chem. Abs.*, **29**, 8254 (1935). Alumina ores containing a comparatively large amount of silicic acid or Ti oxide are fused with a reducing material, lime, and iron compounds. The product is fused with a reducing material and sulfides of heavy metals. Alumina free from Si, Fe, and Ti is produced.

Alumina. ALFRED W. SCHEIDT (Electric Smelting and Aluminum Co.). Can. 353,347, Oct. 1, 1935; *Chem. Abs.*, **29**, 8253 (1935). A furnace charge of aluminous siliceous material is mixed with $CaCO_3$ and alkali aluminate low in Al in substantially the proportions of 1 mol. of Si to 2 mol. of CaO and of 1 mol. of Al to 1 to 1.7 mol. of alkali metal oxide. The charge is heated to form a sinter, and a portion of the Al is separated. The resulting alkali aluminate is returned for reuse.

Alumina. SOC. ANON. D'OUGRÉE-MARIHAYE. Fr. 784,012, July 20, 1935; *Chem. Abs.*, **29**, 8253 (1935). Constituents, particularly Al_2O_3, of natural and artificial silicate materials such as leucites, blast-furnace slags, and alkaline earth silicates formed by fusing bauxites, clays, laterites with the corresponding bases, are extracted by treating the starting material with acid, particularly HNO_3, in

amount such that at any moment of the process, the amount of silicate material is greater than the amount of acid so as to bring to or maintain in the amorphous state the SiO_2 resulting from the treatment.

Alumina production. F. C. FRARY (Aluminum Co. of America). U. S. 2,043,743, June 9, 1936 (Sept. 8, 1934). The process of calcining alum comprises heating the alum at a temperature below its melting point to drive off water, then further heating to a temperature above the temperature at which potassium pyrosulfate is decomposed but below the temperature at which aluminum sulfate decomposes, then still further raising the temperature to decompose the aluminum sulfate constituent of the alum and to drive off gases containing sulfur trioxide, and withdrawing the gases containing sulfur trioxide without contacting them with that portion of the alum which is at temperatures substantially below the temperature at which potassium pyrosulfate decomposes.

Apparatus containing porous parts. I. G. FARBENIND. A.-G. Fr. 788,737, Oct. 15, 1935; *Chem. Abs.*, **30**, 1614 (1936). The porous plates, etc., of filtering or diffusion apparatus are made of a refractory material, such as Si or its alloys or carbides, porcelain, Zr, graphite, SiO_2, or of metals or their oxides, *e.g.*, Fe, Ni, Cu, Ag, MgO, and Al_2O_3. The nonporous part of the apparatus may be of glass or nonvitreous refractory material, but particularly glass known as "Suprax" and "Vitreosil." Breakage between the porous and the nonporous parts does not take place as is the case when both parts are of glass.

Ceramic materials. NORTON CO. Fr. 786,341, Aug. 31, 1935; *Chem. Abs.*, **30**, 1198 (1936). Granules of refractory material, *e.g.*, Al_2O_3, SiC, MgO, or quartz, and a ceramic binder, *e.g.*, a mixture of clays, are mixed with water to form a fluid mass which is then beaten up in the presence of air to form bubbles of air therein. The bubbles are stabilized by an aqueous extraction of sawdust, sulfonated castor oil, saponin, licorice, or bark of saponaria tree. The mass is then dried and fired.

Chrome brick. NIPPON SEITETSU K. K. (Kôji Katô, inventor). Japan. 109,592, Feb. 13, 1935; *Chem. Abs.*, **29**, 4914 (1935). Poor chromite which contains about 22% Cr_2O_3 and serpentine or peridotite is heated at 1400 to 1450° and mixed with substances containing Fe and Mg for use as a material in making chrome brick.

Coatings for furnaces. CARBORUNDUM CO. Fr. 788,861, Oct. 18, 1935; *Chem. Abs.*, **30**, 1966 (1936). Cement or lime furnaces or other chambers subjected to abrasion, *e.g.*, ball or drum mills, are coated with a cast refractory material having a sclerotic hardness of 8 or more. Al_2O_3 containing or not a small amount of Mg, Ca, or Na, or a fused mass of Al_2O_3 and chromite may be used.

Dinas refractories. P. P. BUDNIKOFF. Russ. 39,657, Oct. 31, 1934; *Chem. Abs.*, **30**, 3612 (1936). A binder obtained as waste in the preparation of Al_2O_3 by the soda-lime process is used instead of CaO.

Fireclay brick, etc. P. P. BUDNIKOFF. Russ. 39,658, Oct. 31, 1934; *Chem. Abs.*, **30**, 3610 (1936). In the preparation of brick, etc., fire clay is moistened with a solution of an electrolyte and finely ground clay mixed with a coagulant, such as $AlCl_3$, $CaCl_2$, $FeCl_3$, or $Fe_2(SO_4)_3$, is added.

Furnace construction. A. STURROCK. Brit. 441,395, July 19, 1934; *Brit. Chem. Abs.-B*, **55** [13] 255 (1936). Imperforate fire brick are grooved in such a manner that when assembled they form a perforated hearth suitable for the combustion of fluid or pulverized fuel.

Furnace lining and material therefor. H. H. BLAU AND H. N. BAUMANN, JR. (Carborundum Co.). U. S. 2,043,029, June 2, 1936 (April 19, 1934). A cast refractory article consists of the product obtained upon solidification of a fusion of a mixture consisting essentially of alpha alumina and 1 to 10% of sodium oxide.

Furnace wall. A. H. STEWART. U. S. 2,042,560, June 2, 1936 (Sept. 28, 1934).

Heat-insulation material and process of making. H. W. GREIDER (Philip Carey Mfg. Co.). U. S. 2,042,096, May 26, 1936 (April 18, 1929). Heat-insulation material contains substantial bulk of basic magnesium carbonate and precipitated calcium carbonate, bentonite clay, diatomaceous earth, soft flexible asbestos mineral fiber as a binder material, and amphibole fiber, the fibers of which amphibole fiber are shorter and more frangible than the fibers of the asbestos fiber and have a lower water content and more resistance to high temperatures than the fibers of the asbestos fiber, the amphibole fiber being present in an amount effective to inhibit shrinkage of the insulation material.

High-temperature refractory cement. G. E. SEIL. U. S. 2,042,363, May 26, 1936 (Oct. 12, 1935). A dry cement material for refractory uses comprises essentially heat-treated recrystallized chromite, sodium silicate, and periclase.

Insulating material. PORZELLANFABRIK KAHLA. Fr. 782,028, May 27, 1935; *Chem. Abs.*, **29**, 7038 (1935). Insulating material for high frequency is made from compounds of Ti, particularly TiO_2 or rutile, by ceramic processes, and the molded pieces are submitted to firing in the dense state at above 1000°.

Manufacture of refractory articles. GEORGE WITTY (Construction Products Corp.). U. S. 2,043,640, June 9, 1936 (Jan. 28, 1935; renewed Nov. 25, 1935). The method of manufacturing refractory articles, such as furnace-lining brick, by calcining 40 parts of dolomite, 30 parts of blast-furnace slag, 20 parts ganister, and 10 parts of bauxite, moistening the same with a liquid solution composed of equal parts of calcium magnesium chloride and aluminum chloride to chemically bind these elements and to render them of proper consistency, molding the mixture into brick, and drying it at a temperature between 200° and 400°F.

Plastic refractory insulating material. O. L. JONES (Illinois Clay Products Co. and F. E. Schundler & Co., Inc.). U. S. 2,043,249, June 9, 1936 (Aug. 9, 1933). A plastic refractory insulating material capable when set of withstanding temperatures up to 2700°F without materially weakening or spalling comprises 50 to 70% of exfoliated vermiculite, 15 to 30% of high alumina hydraulic cement, 5 to 15% of plastic fire clay, and 10 to 25% of calcined fire clay.

Porous bodies. MAXWELL L. WHITACRE AND PETER DELEEUW (Carborundum Co.). Can. 353,932, Nov. 5, 1935; *Chem. Abs.*, **30**, 1469 (1936). One of several examples of making porous articles is as follows: Mix 4000 g. of fused Al, 2000 g. of a clay bond, 1600 cc. of H_2O containing 4 g. of acetanilide, and 20 cc. of EtOH for 15 min., add 300 cc. of a 2.5% glue solution and mix 10 min., add 300 cc.

of a 1.5% solution of H_2O_2 and mix for 2 min., place in a mold, and dry at room temperature for 48 hr.

Process of extracting the impurities from mineral raw materials. RICHARD STAUFER AND KAMILLO KONOPICKY (Alterra, A.-G.). U. S. 1,959,448, May 22, 1934 (May 2, 1930).

Process for the preparation of alumina poor in silicic acid from alkaline earth aluminates. JOSEF STÖHR. U. S. 1,978,823, Oct. 30, 1934 (Nov. 12, 1932).

Process for producing spalling-resistant magnesia brick or masses. SILIKA-UND SCHAMOTTE-FABRIKEN MARTIN & PAGENSTECHER A.-G. Brit. 447,525, June 4, 1936 (Sept. 18, 1934).

Refractories and abrasives. CARBORUNDUM CO. Fr. 782,676, June 8, 1935; *Chem. Abs.*, **29**, 7037 (1935). A material for making abrasives and refractories is made by fusing a spinel, or oxides capable of making a spinel, with Al_2O_3.

Refractory and abrasive materials. CARBORUNDUM CO. Fr. 784,820, July 25, 1935; *Chem. Abs.*, **30**, 592 (1936). A product is obtained by fusing Cr_2O_3 and Al_2O_3 to form a solid solution. The content of MgO present should not be above 1.5%.

Refractory brick. DIDIER-WERKE A.-G. Ger. 617,479, Aug. 20, 1935 (Cl. 80*b*. 12.04); *Chem. Abs.*, **29**, 8271 (1935). Fat clay is kneaded under pressure with up to 7% of any of the usual diluents in a finely ground state, if necessary with the addition of water or an aqueous solution of a peptizing agent for clay. The mixture is then molded and fired.

Refractory brick. ÖSTERREICHISCH AMERKANISCHE MAGNESIT A.-G. Fr. 779,447, April 4, 1935; *Chem. Abs.*, **29**, 5620 (1935). See Brit. 418,580. Fr. 779,465, April 5, 1935. Very refractory brick are obtained from MgO and chromite, the latter being predominant, and the sizes of grain of the mixture are proportioned so that the ground material contains grains below about 200μ, preferably below 100μ, and grains above about 1000μ, in amount passing 55% of the total mass.

Refractory brick. C. OTTO & CO. G. M. B. H. Ger. 625,406, Feb. 8, 1936 (Cl. 80*b*. 12.04); *Chem. Abs.*, **30**, 3192 (1936). Addition to 621,283. See Brit. 427,781.

Refractory brick for lining rotary kilns. ÖSTERREICHISCH AMERIKANISCHE MAGNESIT A.-G. Austrian 144,483, Jan. 25, 1936 (Cl. 80*c*.); *Chem. Abs.*, **30**, 3611 (1936). Constructional features are described.

Refractory cement. G. V. KUKOLEV. Russ. 39,295, Oct. 31, 1934; *Chem. Abs.*, **30**, 3612 (1936). A cementing composition suitable for cementing coke ovens while in operation is prepared from ground quartzite and clay with the addition of water-glass and a residue obtained in the extraction of Al_2O_3 from kaolin by the soda-lime method.

Refractory and ceramic materials. M. FOUQUEMBERG. Belg. 409,747, July 31, 1935; *Chem. Abs.*, **30**, 2720 (1936). Slags and ashes (preferably from peat) are ground to an impalpable powder and added to the mix.

Refractory and ceramic products. M. FOUQUEMBERG. Belg. 409,217, May 31, 1935; *Chem. Abs.*, **30**, 2720 (1936). The "lean" ingredients generally used are replaced by slag and ashes ground to an impalpable powder.

Refractory composition. GEORGE J. EASTER AND JOHN C. MCMULLEN (Carborundum Co.). Can. 353,931, Nov. 5, 1935; *Chem. Abs.*, **30**, 2342 (1936). A cast refractory article is made of 50 to 80% Al and over 10% $Fe(CrO_2)_2$. This is effected, *e.g.*, by mixing 25 parts by weight of $Fe(CrO_2)_2$ ore with 75 parts by weight of a fused Al by-product containing approximately 95% Al_2O_3. The chrome spinel takes up the Al in the solid solution, and the Mg and Si are found between the crystals.

Refractory mass. METALLGESELLSCHAFT A.-G. (Emil Lohrke, inventor). Ger. 621,818, Nov. 14, 1935 (Cl. 31*a*. 3.70); *Chem. Abs.*, **30**, 2342 (1936). A mass for making smelting crucibles and for fireproofing ceramic objects consists of a mixture of powdered Al-Si, water-glass, and powdered C. The water-glass is present in amounts of 5 to 50%.

Refractory material. CARBORUNDUM CO. Fr. 782,592, June 7, 1935; *Chem. Abs.*, **29**, 7036 (1935). Refractory objects are molded from a molten mass comprising MgO (2 to 10%) and Al_2O_3 (98 to 90%), its microstructure being composed principally of intermixed crystals of MgO, spinel, and Al_2O_3.

Refractory material. T. R. HAGLUND. Swed. 81,405, Sept. 4, 1934; *Chem. Abs.*, **30**, 3192 (1936). Addition to Swed. 70,995 (*Ceram. Abs.*, **12** [10–11] 381 (1933)). A highly refractory material consisting chiefly of oxides of Mg, Al, and Cr is produced by a melting process. Its contents of oxides of Al, Si, and Fe are kept within such limits that 3 times the percentages of the oxides of Si and Fe added together and in certain cases increased with that part of the percentage of Al_2O_3 which exceeds the half of the percentage of Cr_2O_3 will make a figure not exceeding 60.

Refractory material. MINISTER OF COMMUNICATIONS (Wakasaburô Ogawa and Shizuta Moriyasu, inventors). Japan. 113,648, Dec. 11, 1935; *Chem. Abs.*, **30**, 3611 (1936). A homogeneous mixture of alumina with 0.5 to 3.5% or 29 to 32% magnesia is molded and fired at a temperature below the eutectic point.

Refractory material for glass furnaces. CARBORUNDUM CO. Fr. 787,931, Oct. 1, 1935; *Chem. Abs.*, **30**, 1536 (1936). See Can. 351,679.

Refractory materials. DEUTSCHE CARBORUNDUM-WERKE G. M. B. H. Ger. 616,225, July 28, 1935 (Cl. 80*b*. 8.18); *Chem. Abs.*, **29**, 7606 (1935). See Brit. 326,-560.

Refractory materials. DIDIER-WERKE A.-G. Ger. 601,192, Dec. 12, 1935 (Cl. 80*b*. 18.03); *Chem. Abs.*, **29**, 6384 (1935). Addition to 594,000 (*Ceram. Abs.*, **13** [10] 266 (1934)). In making the highly fireproof insulating material of 594,000 from sawdust, chamotte, kaolin, etc., the sawdust is swelled with water before mixing with the other materials.

Refractory materials. FERRO ENGINEERING CO. Ger. 624,312, Jan. 17, 1936 (Cl. 80*b*. 8.06); *Chem. Abs.*, **30**, 2720 (1936). See Brit. 428,228.

Refractory materials. VICTOR M. GOLDSCHMIDT. Ger. 618,094, Sept. 4, 1935 (Cl. 80*b*. 8.08); *Chem. Abs.*, **30**, 260 (1936). Minerals consisting mainly of Mg orthosilicate and containing no more than 10% of Fe, calcined as FeO, are worked into mixtures, comprising mineral powder associated with granules or pieces of the mineral, and the mixtures are sintered without fusion in an oxidiz-

ing atmosphere and then, if desired, in a reducing atmosphere. The mixtures may be melted before they are sintered. Olivine is the preferred mineral.

Refractory materials. VICTOR M. GOLDSCHMIDT. Fr. 790,877, Nov. 28, 1935; *Chem. Abs.*, **30**, 3192 (1936). Refractory products are made by firing without fusing mixtures of an olivine rock in grains or (and) pieces and a powdered olivine rock, the rock used containing olivine at least 70 (corresponding to Mg orthosilicate 60), Fe (calcined as FeO) below 10, Mg hydrosilicates below 10, rhombic pyroxene below 20, monoclinic pyroxene below 10 (preferably below 5), and feldspar below 10% (preferably below 2) by weight. Substances rich in Cr may be added in a finely divided state so that the product contains 0.3 to 10% Cr_2O_3. Chromite may be added in the form of grains.

Refractory materials. HARBISON-WALKER REFRACTORIES CO. Fr. 784,832, July 25, 1935; *Chem. Abs.*, **30**, 592 (1936). Between the grains of magnesian refractory material is formed a binder containing a network of forsterite in amount such that the material is made mechanically resistant to high temperatures as compared with material not containing the network. The forsterite is formed *in situ* on heating.

Refractory materials. E. J. LAVINO & CO. Fr. 781,276, May 11, 1935; *Chem. Abs.*, **29**, 6384 (1935). A substance which is useful in the manufacture of refractory products and as an abrasive is made by heating a Cr ore containing chromite to at least 1705° and cooling suddenly, whereby the particles of chromite are recrystallized and the gangue is distributed on the surface of the particles in a form similar to glass. Crude Cr ore may be mixed with the product to make refractories.

Refractory materials. SOC. ANON. D'ISOLANTS & RÉFRACTAIRES (Frederic C. Le Coultre, inventor). Fr. 788,775, Oct. 16, 1935; *Chem. Abs.*, **30**, 1966 (1936). A small amount (2% of the total mass) of the product known as "Kenn cement" or "English cement" is used as a binder to agglomerate refractory products having a basis of Zr silicate.

Refractory metallic vessel for holding ceramic products during treatment in muffle furnaces. PORZELLANFABRIK KAHLA. Ger. 625,386, Feb. 8, 1936 (Cl. 80*c*. 17.01); *Chem. Abs.*, **30**, 3192 (1936).

Refractory pots for glassmaking. RENÉ AMAND. Fr. 45,306, July 22, 1935; *Chem. Abs.*, **30**, 2720 (1936). Addition to 755,171 (*Ceram. Abs.*, **13** [8] 214 (1934)).

Refractory product. CARBORUNDUM CO. Fr. 788,862, Oct. 18, 1935; *Chem. Abs.*, **30**, 1966 (1936). A refractory material, *e.g.*, for the container of glass furnaces, comprises principally corundum and a glass placed between the crystals, or corundum and mullite in the proportion of at least 2 to 1 buried in a vitreous base.

Refractory products. COMPAGNIE DE PRODUITS CHIMIQUES ET ÉLECTROMÉTALLURGIQUES ALAIS, FROGES & CAMARGUE (M. Kortschak, applicant in Austria). Fr. 788,482, Oct. 10, 1935; *Chem. Abs.*, **30**, 1535 (1936). Brick, linings and protective layers for furnaces, etc., are made without firing by intimately mixing powdered clay, grog, SiO_2 and Al_2O_3, calcined quartzite, zircon, bauxite, kieselguhr, etc., with a binder consisting of substances of high molecular weight, such as residual lye from the sulfite manufacture of cellulose, and a soluble metasilicate, if desired, with the addition of $FeSO_4$ and crystallized graphite and with or without water. The mixture may be treated with steam to bring it to the required consistency for molding.

Retort construction. J. N. VANDEGRIFT (Coal Products Co.). U. S. 2,041,882, May 26, 1936 (March 5, 1931).

Silica articles. FRANZ SKAUPY. Ger. 621,936, Nov. 15, 1935 (Cl. 32*a*. 35); *Chem. Abs.*, **30**, 3191 (1936). Addition to 611,098 (*Ceram. Abs.*, **14** [9] 222 1935)). The process of Ger. 611,098 is effected at atmospheric or reduced pressure in an atmosphere of an easily diffusing gas, particularly H or He.

Silicon carbide refractory. R. C. BENNER, G. J. EASTER, AND A. J. THOMPSON (Carborundum Co.). U. S. 2,041,808, May 26, 1936 (Dec. 8, 1932). A silicon carbide refractory in which from 70 to 90% of the silicon carbide is coarser than 80-mesh and substantially all the rest of the silicon carbide is finer than 80-mesh but coarser than 200-mesh, the refractory having a density between 2.0 and 2.3 and comprising from 2 to 20% of an added ceramic binder, is described.

Vertical retorts for the carbonization of coal, etc. WEST'S GAS IMPROVEMENT CO., LTD., F. J. WEST, AND E. WEST. Brit. 446,601, May 13, 1936 (Feb. 13, 1935).

Zirconia; refractories. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 429,367, May 29, 1935; *Chem. Abs.*, **29**, 7028 (1935). Crystalline ZrO_2 is obtained by fusing zircon at 2000° or over and removing the vitreous SiO_2 from the cooled product by treatment with HF. Alternatively, the bulk of the SiO_2 may be removed as a soluble silicate, *e.g.*, by fritting the product with an alkali carbonate and washing with H_2O, and the last traces then removed with HF. Crystalline refractories may be obtained by fusing zircon with a metallic oxide, *e.g.*, Al_2O_3, CaO, or MgO, to give a mixture of crystalline ZrO_2 and a crystalline silicate of the added oxide. By fusing zircon 20 to 30 and Al_2O_3 80 to 70%, a material suitable as an abrasive, electrical insulation, or refractory is obtained.

Terra Cotta

Accelerated method for determining wear caused by abrasion. F. D. SNELL AND K. W. HAESELER. *Ind. Eng. Chem., Anal. Ed.*, **8** [3] 191–94 (1936).—Equipment was designed to measure the comparative rate of wear of travertine and an artificial travertine flooring. A silicon carbide block fastened to a reciprocating arm was loaded to a weight of 3000 g. and operated at 30 cycles/min. Observation shows that after the surface skin is removed from the stone a steady rate of wear is obtained with the particles of fine dust from the stone as the actual wearing agent. The silicon carbide block does not contact the stone. By replacement of the block with chalk, the equip-

ment was used for measurement of the rate of wear of a glass blackboard. Illustrated. F.G.H.

Effects of smoke on building materials. H. B. Meller and L. B. Sisson. *Ind. Eng. Chem.*, **27** [11] 1309–12 (1935).—Reports and observations show continuation of excessive air pollution and resultant damage to building materials. See *Ceram. Abs.*, **15** [4] 137 (1936). F.G.H.

Manufacture and use of acid-resistant brick. R. Klesper. *Sprechsaal*, **69** [9] 117–19; [10] 131–33; [11] 147–49; [12] 159–61 (1936).—The nature and structure of clays used in the manufacture of acid-resistant brick are discussed. The manufacture of brick and the properties of high-grade boiler brick are described. Diagrams show the manner in which the brick are used to line iron acid tanks. A series of suitable densening media is dealt with. The use of dense brick for furnaces with chemical effects is discussed. M.V.C.

Temperature control as to oscillations of internal conditions and to characteristics of walls. Emerson M. Pugh. *Instruments*, **9** [5] 129–32 (1936).—While the average flow of heat through a wall can be calculated in the usual manner from the average internal and external temperatures, this flow is not the significant quantity in designing cooling systems for buildings, but rather the maximum flow, which can not be calculated so simply. The heat flow due to the sun effect through different types of roof panels has been reported and a complex mathematical solution of the problem published by P. This paper presents a series of curves for practical solution of the problem. Application to 4-in. gypsum panels exposed to the sun showed good correlation between calculated and observed inner temperatures. R.W.R.

PATENTS

Brick, tile, etc. Max Perkiewicz. Ger. 621,441, Nov. 7, 1935 (Cl. 80*b*. 12.11); *Chem. Abs.*, **30**, 1197 (1936). Addition to 545,237. Molded clay, before it is dried and fired, is treated with a suspension containing a natural or synthetic resin and a clay or a mixture of clays, with or without a protective colloid, a flux, or a glaze. In this way the color of the final products is not only levelled, as described in Ger. 545,237, but can also be modified as desired by suitable selection of the clay, etc., added to the resin suspension.

Ceramic materials. Georges E. H. Grenard and Étienne J. Dusseris. Fr. 782,116, May 28, 1935; *Chem. Abs.*, **29**, 7036 (1935). A multicellular heat- and sound-insulating material is made by firing mixtures of clay and a combustible material, the constituents being brought separately to a dry powdered state, mixed dry, and then wetted and beaten up. SiO_2 and CaF_2 may be incorporated.

Electric insulators for use on very high radio frequencies. Marconi's Wireless Telegraph Co., Ltd., and H. A. Ewen. Brit. 446,549, May 13, 1936 (Feb. 21, 1935).

Insulator. C. B. Van Atta (Locke Insulator Corp.). U. S. 2,043,523, June 9, 1936 (Nov. 26, 1926).

Salt-glazing on earthenware. A. A. Aksenov-Sosov. Russ. 39,661, Oct. 31, 1934; *Chem. Abs.*, **30**, 3612 (1936). A glazing composition of NaCl, wood ashes, and finely ground quartz sand is placed on the earthenware and this is fired in the usual manner.

Salt-glazing pottery. Fritz H. Zschacke. Ger. 626,-217, Feb. 21, 1936 (Cl. 80*b*. 23.03); *Chem. Abs.*, **30**, 3612 (1936). A brown glaze is produced on pottery by introducing soda into the firing kiln, suitably as a subdivided aqueous solution. Alternatively, an aqueous NaOH solution may be sprayed into the kiln.

Whiteware

Brown glaze for high-tension insulators. O. A. Ruidalchuk. *Keram. i Steklo*, **12** [1] 20–22 (1936).—A discussion is given of the properties required of glazes for high-voltage insulators. Attempts to produce a high-quality brown glaze for them are described. The chemical composition of the brown glaze developed corresponds to Seger's formula:

Na_2O	0.012	Al_2O_3	0.800		
K_2O	.247	Fe_2O_3	.080	SiO_2	7.03
MgO	.001	Cr_2O_3	.044		
CaO	.680	Mn_2O_3	.150		

M.V.C.

Electrical porcelain and porosity. L. E. Barringer. *Gen. Elec. Rev.*, **38** [7] 308–11 (1935).—The importance of low porosity in electrical porcelain is stressed. The structure must be free from flaws and open and closed pores, as such imperfections seriously decrease the dielectric value. The difference between dry-process and wet-process (cast or extruded) porcelain lies in the internal structure, the former being coarser in texture and slightly porous, the latter smooth, dense, and homogeneous. Rigid control in all stages of manufacture is necessary to to maintain a high-grade product. Comparative data on dielectric strength, pore volume, and tensile and compressive strengths are given. Modern equipment, such as continuous vacuum filters, vacuum pugmills, humidity controlled driers, and modern tunnel kilns, is used in the present-day manufacture of electrical porcelain. Illustrated. L.E.T.

Freezing of pyrometric cones. R. F. Rea and M. C. Shaw. *Jour. Amer. Ceram. Soc.*, **19** [7] 192–95 (1936).

Physical-chemical reactions in firing whiteware. T. N. McVay. *Jour. Amer. Ceram. Soc.*, **19** [7] 195–201 (1936).

Testing porcelain bushings by recording the dielectric phase angle. Geo. Keinath. *Arch. tech. Messen*, **5** [58] T45 (1936).—The procedure of measuring the tangent of the phase angle between the testing voltage and current is described and illustrated by an example. M.H.

BOOK

More ceramic insulation materials (Mehr keramische Isolierstoffe). W. Demuth, E. Kunstmann, H. v. Treufels, and W. Weicker. German Assn. of Electrical Porcelain Manufacturers, Berlin, 1936. 23 pp. Price 2 Rm. This booklet deals with the latest developments in ceramic insulation materials. Porcelain, steatite, and other magnesium-silicate bodies are described. The recently developed titanium bodies for high dielectric con-

stant and high frequency application have been classified. A detailed table giving all physical and electrical constants, dielectrical and mechanical strength, density, and thermal expansion is attached. Illustrated. L.E.Thiess

PATENTS

Ceramic products. JACQUES G. A. LEFRANC. Fr. 781,419, May 15, 1935; *Chem. Abs.*, **29**, 6384 (1935). Ceramic products are made from an inert material such as sand and a binder composed on the one hand of $ZnCl_2$, $MgCl_2$, $CaCl_2$, etc., in concentrated solution and on the other hand an alkaline earth or earth base, or certain basic compounds such as blast-furnace slags. Alkaline earth phosphates which form a binder by dehydration or by reaction with oxides, carbonates, blast-furnace slag, or the above chlorides may also be used.

Coloring clinker ware. FRITZ ECKERT, PAUL ECKERT, AND RICHARD ECKERT. Ger. 587,828, Feb. 17, 1936 (Cl. 80*b*. 23.07); *Chem. Abs.*, **30**, 3611 (1936). Clinker ware is colored by treatment with flue gases at high temperatures, sufficient NaCl vapor being added to form a glaze.

Dielectric ceramic material. PORZELLANFABRIK KAHLA. Fr. 787,387, Sept. 21, 1935; *Chem. Abs.*, **30**, 1198 (1936). Substances such as TiO_2 in different forms (amorphous TiO_2, titanic acid, brookite, anatase, or alkaline earth titanate) are added to ceramic compositions in amount sufficient to give a dielectric constant independent of the temperature.

Earthenware. FRIEDRICH R. REININGHAUS. Swiss 177,509, Aug. 16, 1935 (Cl. 8*b*.); *Chem. Abs.*, **30**, 3611 (1936). Clay and stoneware are improved by coating with metal, *e.g.*, by spraying, instead of coating with the usual glaze.

Electric insulators. CHAMPION SPARK PLUG CO. (Frank R. Riddle, applicant in U. S.). Fr. 780,902, May 6, 1935; *Chem. Abs.*, **29**, 5950 (1935). A fritted insulating material capable of withstanding high temperatures contains SiO_2 5 to 22.5, Al_2O_3 at least 37.5, and MgO not more than 50%. The amount of MgO is at least sufficient to transform all the SiO_2 into forsterite and 90% of the Al_2O_3 into spinel.

Electrical resistances and heating elements. MAX HAUSER. Ger. 623,410, Dec. 20, 1935 (Cl. 21*h*. 1); *Chem. Abs.*, **30**, 2342 (1936). An ordinary crude ceramic material or composition is mixed with powdered or granular Si, or an alloy containing at least 70% of Si, and with a flux, *e.g.*, borax or a water insoluble borate frit. Other metals or alloys, *e.g.*, Fe-Cr, may also be added. The mixture is then shaped and fired by the usual ceramic methods. Precautions to avoid oxidation are unnecessary. A specified composition contains Si 30, clay 55, and borate frit 15%.

Fusing metals into pottery. KARL SCHINDHELM. Ger. 613,327, May 17, 1935 (Cl. 80*b*. 16.02); *Chem. Abs.*, **30**, 591 (1936). Addition to 610,922.

Glazes, etc. ERICH HEINZ. Fr. 44,786, April 6, 1935; *Chem. Abs.*, **29**, 6384 (1935). Addition to 750,548. Ba borosilicate is used as a flux in making glazes, enamels, etc. An example contains feldspar 26, quartz 2, minium 49, and Ba borosilicate 15 parts. This may be applied with coloring materials to pottery after a simple grinding without fritting.

Insulator. STEATIT-MAGNESIA A.-G. (Hugo Berenz and J. Gingold, inventors). Ger. 611,854, April 8, 1935 (Cl. 21*c*. 2.01); *Chem. Abs.*, **29**, 5950 (1935). A high-tension insulator consisting principally of $MgO(Al_2O_3)SiO_2$ is made from MgO 8 to 13, Al_2O_3 31 to 43, and SiO_2 49 to 55%, with a heavy metal oxide such as Fe_2O_3 as flux.

Pottery. SCHÜTTE A.-G. FÜR TONINDUSTRIE (Theodor Schumann, inventor). Ger. 626,112, Feb. 29, 1936 (Cl. 80*b*. 23.03); *Chem. Abs.*, **30**, 3611 (1936). An aqueous sludge of clay containing a peptizing agent, *e.g.*, an alkali, is diluted, preferably by addition of ice, until its specific gravity is 1.2 or less. The coarser constituents are removed by sedimentation or centrifuging, and the suspension, as such or after concentration, is then applied as a coating to pottery, which may have been made from the same clay. Articles having a terra sigillata finish are obtained when the pottery is fired. Colloidal metal oxides may be added to the clay suspension to modify the color.

Tiling. A. C. MYERS (Kraftile Co.). U. S. 2,043,706, June 9, 1936 (Jan. 25, 1933). A mounting for facing tile having longitudinally disposed grooves in their edges spaced a predetermined distance is described.

Ventilated plumbing fixture. T. J. ROBERTSON (Paul C. Ford). U. S. 2,041,962, May 26, 1936 (June 22, 1934).

Vitreous compositions. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Fr. 44,706, April 6, 1935; *Chem. Abs.*, **29**, 6384 (1935). Addition to 767,372 (*Ceram. Abs.*, **14** [8] 204 (1935)). Compositions containing SiO_2 (10), cryolite (10), boric acid (35), salts of Pb (minium 30), and (or not) feldspar (15 parts) are used as fluxes for the Mg micas to give products of high dielectric quality and resistance to water.

Equipment and Apparatus

Air-damped balances. W. N. BOND. *Analyst*, **61** [719] 85–90 (1936).—The need for rapid weighing is leading to new designs in chemical balances. Air-damped balances are said to be more permanently accurate than chainomatic. H.H.S.

Brickmaking machines: II. J. HAUSEN. *Eng. Progress*, **17** [3] 61–64 (1936).—Modern German brick presses, cutters, handling equipment, and drying plants are described. 14 photos. For Part I see *Ceram. Abs.*, **15** [5] 158 (1936). J.L.G.

Carbon monoxide analyzer. ELDON A. MEANS AND E. L. NEWMAN. *Refiner & Natural Gasoline Manufacturer*, **15** [5] 191–92 (1936).—Good results were secured with flue gases. R.W.R.

Combined color-pyrometer with a comparison lamp. GERHART NAESER. *Arch. Eisenhüttenwesen*, **9** [10] 483–85 (1936).—A combination color pyrometer is described which determines the true temperature of all not selectively radiating heat rays with an average exactness of

±10°. The presence of black rays can be determined in one measurement. M.V.C.

Combustion safeguard. Brown Instrument Co. Div. of Minneapolis-Honeywell Regulator Co. *Instruments*, **9** [5] 123 (1936).—An improved form of the "Protectoglo" equipment for safeguarding gas- or oil-fired furnaces can be supplied for practically any type of burner equipment. R.W.R.

Crucible furnace. R. Hoe & Company. *Foundry Trade Jour.*, **53** [985] 13 (1935).—A new type of crucible furnace consists of a casing lined with refractory material which is sunk for about half its height below the ground. It differs, fundamentally, from the pit-fired furnace in that the grate bar is replaced by an easily-removable grill. The front of the ash pit is sealed by a well-fitting shutter and beneath the grill is introduced, by means of a flexible pipe, a blast of air from a fan which is driven by a $^1/_3$-h.p. motor. The fuel consumption has been reduced from 120 lb. to 30 lb. of coke and the melting time from $2^1/_2$ hr. to 50 min. in melting a 150-lb. charge of gun-metal. H.E.S.

Design of a precision photoelectric colorimeter. R. B. Withrow, C. L. Shrewsbury, and H. R. Kraybill. *Ind. Eng. Chem., Anal. Ed.*, **8** [3] 214–19 (1936).—The principles of design of precision photoelectric colorimeters are discussed. Illustrated. F.G.H.

Double-action crusher. Fr. Korte. *Eng. Progress*, **17** [3] 71–72 (1936).—The low power consumption and large output of the double-action crusher are stressed. Four screen analyses of the crushed product are given. Two photographs. J.L.G.

Electronic apparatus in industry: I. G. Windred. *Power & Works Engr.*, **31**, 125–27 (1936).—Electron physics for the engineer more familiar with heavy equipment is discussed. F.P.P.

Fundamentals of rock milling. A. W. Fahrenwald. *Eng. Mining Jour.*, **137** [3] 142–43 (1936).—By "rock milling," F. means the grinding of rock or ore with or by rock or ore. The mill used in this study was 35 in. in diameter by 8 in. in length. The speed used was 36 r.p.m. A fine-grained basalt and a hard, white quartz were ground. Rock pieces 2 to 3 in. in size were loaded in to 40% of the mill by volume. Water was added to fill the void spaces. Results showed that the abrasion rate decreases with time and that the percentage production of minus 200-mesh material increases with time of tumbling or as the pieces increase in roundness. F. believes this method will, upon perfection, supersede ball-mill grinding for many purposes. Illustrated. J.L.G.

Heat-resisting chrome irons. P. Bastien. *Chaleur & Ind.*, No. 189, p. 13 (1936); *Jour. Soc. Glass Tech.*, **20** [78] 113A (1936).—Cast irons containing up to 5% Cr were pearlitic, being gray irons with 2% Cr and white irons over 2% Cr; 0.5 to 0.7% Cr gave an iron suitable for temperatures as high as 800°, with a shear strength of 30 to 45 kg./mm.^{2} Irons with 1 to 3% Cr could be used at 900°, but were hard and brittle. High chrome irons were very heat resistant. The composition of the best chrome irons followed the relationship Cr% = 13 + 10 C%. Thus 2.7% C and 40 Cr was the composition of an iron for use at temperatures around 1000°.

Heat transfer and diffusion. W. Hoffmann. *Forsch. Gebiete Ingenieurw.*, **6A** [6] 293–304 (1935).—The analogy between heat transfer and diffusion is discussed, and experimental equipment and procedure for studying it are described. Measurements are made of flow in a pipe, flow parallel to plane surfaces, flow around pipes in an axial direction, and flow against small plates under different angles of impingement. A tube-nest model with inflow and outflow in different directions is described, and results are successfully applied to large temperature differences. F.P.P.

Heat transfer by free convection on square plates. R. Weise. *Forsch. Gebiete Ingenieurw.*, **6A** [6] 281–92 (1935).—The total heat loss by free convection from two aluminum plates in horizontal and vertical positions, with surface temperatures from 50 to 350°C, was measured. The heat transfer coefficient over the entire temperature range was, for both plates, 20% smaller in the horizontal than in the vertical position. Schmidt and Beekmann's formula, with a change of factor, may be applied to the vertical position measurements. Complete description of apparatus and experimental procedure and photographs of the temperature-field striae are included. F.P.P.

High-speed micro-switch. Production Instrument Co. *Instruments*, **9** [5] 127 (1936).—One-half inch-ounce of energy operates this new smaller model, type ES-9. It is suited to the operation of counters, recorders, signaling, etc. R.W.R.

Hunter gloss comparator. Henry A. Gardner Laboratory. *Instruments*, **9** [4] 99 (1936).—This instrument is particularly applicable to the study of high gloss surfaces which reflect images. It is equipped to measure the "distinctness-of-image" type of gloss on a scale graded from 0 to 100. With the camera which is furnished, the instrument can be used to photograph and give permanent records of gloss and surface texture. R.W.R.

Influence of high viscosity on the flow around cylinders. Fritz Homann. *Forsch. Gebiete Ingenieurw.*, **7A** [1] 1–10 (1936).—The conditions that contribute toward fictitious pitot-tube measurements are studied in two ways; this paper covers the experimental treatment. With high viscosity there is involved a correction of the back-pressure formula, $P = Qv^2/2g$. Determinations of the velocity of flow around cylinders for 3 different Reynolds numbers were made. The experimental outfit developed by H. permitted measuring both the pressure distribution on the cylinder and the velocity distribution in its wake. F.P.P.

Inspection polariscope. R. Fuess, Inc. *Instruments*, **9** [5] 123 (1936).—A new cabinet-type polariscope has been developed for convenient inspection of glass articles or equipment. Large articles may be inspected. R.W.R.

Instrument for photometric and colorimetric measurements, using the photometric distance law. F. Anselm and F. Würstlin. *Z. tech. Physik*, **16**, 157–61 (1935).—A lamp is arranged between two white shades. The lamp can be moved and its position can be read relatively to the two shades. Adjustment is made in such a way that both shades have the same brightness. Measurements are made visually or by means of two photocells in a compensating hookup, using a galvanometer as an indicating instrument. The position of the lamp can be cali-

brated against extinction values and the determination of the concentration of solutions. Turbidity, color, p_H, and gloss measurements can be made with this instrument. W.M.C.

Instruments for measuring high temperatures. MANGOLD. *Maschinenbau*, **14** [21-22] 621–26 (1935); *Bull. Brit. Non-Ferrous Metals Research Assn.*, No. 82, p. 19 (Dec., 1935).—Thermometers, resistance thermometers, and pyrometers are discussed. Notes on numerous German instruments are given.

Instruments for measuring small pressures. H. LOHMANN. *Chem. App.*, **23** [7] 57–59 (1936).—A vacuum balance for measuring 75 to 100% vacuum or 0 to 190 mm. Hg is described. It consists of a U-tube supported on a knife bearing; the U-tube is tilted by the mercury in the tube when the pressure changes and transmits its movement to a dial or recorder. Another instrument, a float manometer, uses a float on the mercury which records its position with varying pressures. Both instruments can be used for remote indication and control. M.H.

Measurement and control of processing temperatures: I–II. *Power & Works Engr.*, **31**, 92–94, 145–49 (1936).—A brief description of the operating principles of various electrical-resistance thermometers and thermoelectric pyrometers is coupled with a detailed discussion of thermocouple metals and protecting tubes, connecting leads, installations of instruments, and general applications. F.P.P.

Oxford impact machine. R. V. SOUTHWELL. *Engineering*, **140** [3627] 54–55 (1935).—The "Oxford" impact machine is designed to eliminate any possibility that energy may be transferred to earth by shock, on the premise that energy so transferred would be erroneously included in the estimated "work of fracture." This is accomplished by using an entirely separated anvil and striker, each suspended by flexible wires. The advantages are as follows: (1) the specimen is cheaper and easier to make; (2) the test is a more definite indicator of shock-resisting qualities, and (3) more consistent results are obtainable and the impact figure obeys an intelligible dimensional law. Illustrated. H.E.S.

Photoelectric reflectometer. HENRY A. GARDNER LABORATORY. *Instruments*, **9** [4] 96 (1936); see *Ceram. Abs.*, **15** [6] 185 (1936). R.W.R.

Principles and practice of drying in industry. E. KNOWLES. Read before Inst. of Engineers-in-Chief, St. Bride Inst., March, 1934; abstracted in *Indian Eng.*, **96** [26] 516–18 (1934).—K. refers to the basic principles applicable to nearly all drying problems and discusses the practical application of these principles. A.P.S.

Pug mills with double mouthpieces; a possible cure for core cracking. ANON. *Brit. Clayworker*, **45** [529] 48 (1936).—Two designs of mouthpiece are shown. In one the clay travels finally at right angles to the pug-mill axis, and in the second at an obtuse angle. An equal flow of clay was assured by the insertion of a hardwood wedge extending across the pug-mill barrel and nearly reaching the end of the knife shaft. R.A.H.

Relation between thermal conductivity and moisture content of ground matter, with reference to the drying process. A. W. LYKOW. *Kolloid-Z.*, **69** [2] 226–30 (1934); see *Ceram. Abs.*, **14** [11] 286 (1935). F.P.P.

Reversible gas electrodes: a simple thermodynamical exposition of operation. J. W. H. LUGG. *Jour. Australian Chem. Inst.*, **3**, 126–30 (April, 1936).—A formulation is given of the single-electrode potential in which the characteristics of the electrode metal are taken into consideration and provision is made for Volta effects in the measured e.m.f. H.H.S.

Sand wizard. PARKINSON STOVE CO., LTD. *Foundry Trade Jour.*, **53** [988] 64 (1935).—A new type of shot-blast cleaning machine is described. The sand is projected by centrifugal force instead of by compressed air. A tumbling barrel carries the castings and rotates slowly, while the contents are subjected to a double stream of No. 18 chilled iron grit. Power requirements are less, time of cleaning is reduced, and a superior surface for enameling is obtained with this method of cleaning. H.E.S.

Silicon irons. L. GUILLET. *Chaleur & Ind.*, No. 189, pp. 14–15 (1936); *Jour. Soc. Glass Tech.*, **20** [78] 113A (1936).—A résumé was given of the silicon irons as heat-resistant materials. All silicon irons were brittle and had a low mechanical strength. A ferritic hypo-eutectic iron containing 6% Si and 2.8 C gave satisfactory heat-resisting properties up to 950° with a strength of 10 to 12 kg./mm.^{2}

Small-bulb gas-filled recording thermometer. BRISTOL CO. *Instruments*, **9** [5] 126 (1936).—This thermometer is available in various ranges between −60°F and 1000°F and with tubing lengths up to 100 ft. or longer. R.W.R.

Uses for the psychrometric chart in simplifying air conditioning problems: I. WILLIAM GOODMAN. *Heating, Piping, & Air Conditioning*, **8** [2] 87–90, 92 (1936).—Absorption of sensible heat gains, absorption of moisture by the air supply, absorption of total heat gain, and the use of the psychrometric chart in the calculations involved are considered. Three charts. **II.** *Ibid.*, [3] 147–50.—The explanation of the solution of air-conditioning problems by means of a psychrometric chart is continued with typical examples. The use of the method in determining the required state of the air supply to meet given room conditions and conditions which can be maintained with a given air supply are considered. Five charts. **III.** *Ibid.*, [4] 197–99.—Cases where the sensible heat ratio is so low as to require reheating are discussed. Four charts. J.L.G.

Vacuum-cell luminescence microscope and its use in the study of luminescent materials. JOHN GALLUP. *Jour. Opt. Soc. Amer.*, **26** [5] 213–15 (1936); abstracted in *Phys. Rev.*, **49** [8] 647 (1936).—A new type of luminescence microscope is described. Its use in the examination and comparison of materials luminescing under electron bombardment in vacuum is explained. Fields of self-luminous particles are obtained of sufficient brightness to permit of satisfactory visual observation at magnifications up to 500×. Good photomicrographs can be made at 100× with ordinary film. In the study of manganese-activated calcium silicates, this microscope has facilitated the determination of many of the relationships which exist between color of luminescence, intensity of luminescence, and crystal form. The low-temperature form of calcium metasilicate luminesces more brightly than any other calcium silicate studied. A thorough wet mixing of

raw materials is necessary to obtain a product of uniform luminescence. J.L.G.

BULLETIN

Dewatering clay suspensions by spray evaporation. HEWITT WILSON, GEORGE A. PAGE, AND VANCE CARTWRIGHT. *Bur. Mines Rept. of Invest.*, No. 3248, 42 pp. For abstract see *Ceram. Abs.*, **14** [4] 103 (1935). R.A.H.

PATENTS

Apparatus for drying tile and like thin articles. ERDUIN SCHONDORFF. Ger. 614,369, June 6, 1935 (Cl. 82*a*. 26); *Chem. Abs.*, **29**, 6009 (1935).

Clayworking machine. C. M. STEELE. U. S. 2,041,619, May 19, 1936 (April 20, 1935).

Electric furnace for heat-testing refractory products. DANIEL PETIT. Fr. 784,105, July 22, 1935; *Chem. Abs.*, **30**, 260 (1936).

Electric furnaces for high temperatures. JEAN A. CULMANN. Fr. 791,178, Dec. 5, 1935; *Chem. Abs.*, **30**, 2861 (1936). The heating element is a Mo or W wire wound around a tube of special porcelain, impermeable to gases and resistant to high temperatures. The wire is imbedded in an aluminous refractory cement.

Filter. FRITZ JAEGER. U. S. 2,037,134, April 14, 1936 (May 5, 1934).

Glazing apparatus. D. B. HOWELL. U. S. 2,041,765, May 26, 1936 (April 30, 1932).

Means for feeding molten material into receptacles. C. J. BEAVER, T. J. FAIRFIELD, AND W. T. GLOVER & CO., LTD. Brit. 446,686, May 20, 1936 (Nov. 8, 1934).

Molds for casting ceramic articles. F. S. SEMYACHKOV. Russ. 39,656, Oct. 31, 1934; *Chem. Abs.*, **30**, 3611 (1936). The forms are prepared from tripoli fired at 700 to 900°.

Refining clay. CURT KABUS. Ger. 625,318, Feb. 7, 1936 (Cl. 80*b*. 12.01); *Chem. Abs.*, **30**, 3191 (1936). An aqueous suspension of clay is decanted from coarser impurities and then allowed to settle in vessels having a bottom filtering surface comprising a layer of fine sand covered by a layer of porous textile or metal fabric.

Rotary-drum filter. RENÉ A. HENRY. Ger. 626,354, Feb. 25, 1936 (Cl. 12*d*. 15.02); *Chem. Abs.*, **30**, 3284 (1936). See Fr. 741,401.

Rotary-drum filter. HUMBOLDT-DEUTZMOTOREN A.-G. Ger. 626,170, March 2, 1936 (Cl. 12*d*. 15.02); *Chem. Abs.*, **30**, 3284 (1936).

Kilns, Furnaces, Fuels, and Combustion

Blast-furnace fuels, anthracite coal. RALPH H. SWEETSER. *Metals Technology* (Feb., 1935); reprinted in *Indian Eng.*, **97** [3] 25–27 (1935).—A brief review of the most important natural blast-furnace fuel shows that anthracite was used for over three-quarters of a century without its character being well known and its superior qualities recognized. Possibly present blast-furnace practice could be much improved if we understood better what takes place with by-product coke within the big column near the center of the furnace and what happens in the region between the level of the tuyères and the iron notch. It would be worth while to determine whether the superior quality of anthracite pig iron was due to the anthracite alone or partly to the small diameter of the anthracite blast furnaces. A.P.S.

Calculation of heat flow as a function of time and space by the E. Schmidt approximation method. H. KRAINER. *Feuerungstechnik*, **24** [1] 4–7 (1936).—The approximation method of E. Schmidt, based on calculations of 1- and 2-dimensional thermal flow changing with time, is discussed and applied to a 3-dimensional thermal flow, depending on time for anistropic and heterogeneous bodies. M.V.C.

Ceramic firing processes: IV, Effect of firing conditions on vitrification processes. OTTO KRAUSE AND EBERHARD KEETMAN. *Sprechsaal*, **69** [16] 221–25 (1936).—Three ceramic mixes containing quartz and feldspar and fired under different conditions were studied for their linear and volume shrinkage and for their apparent and true porosity to determine the effect of firing temperature, duration of firing, and furnace atmosphere on vitrification processes. It was found that the two structural processes leading to the formation of the melting phase, *viz*, liquefying of feldspar and dissolving of quartz by liquid feldspar, are a cause of vitrification. The increase of shrinkage and decrease of porosity correspond to structural changes and are directly proportional to the log of time. Sintering processes are also affected by other factors, such as viscosity and surface tensions of the melting phase. The increase of volume shrinkage and the decrease of porosity are directly proportional to the feldspar content of the mix at lower firing temperatures (1100°). The rate of vitrification is practically exclusively determined by the velocity of liquefaction of the eutectic feldspar in this temperature range. At higher temperatures (even at 1200°, although with longer firing time) the sintering processes are promoted; a dissolving of quartz occurs and the liquefaction of feldspar proceeds more rapidly. At 1300° an almost instantaneous melting of feldspar occurs. Viscosity decreases to such an extent that surface stresses appear as well as an increased dissolving of quartz. Of importance is the determination that true porosity increases in dependence on the duration of firing and feldspar content, for which no satisfactory explanation has yet been found. The furnace atmosphere has no effect on sintering processes at higher temperatures (1300 and 1400°); at lower temperatures (1100° and 1200°), however, the reducing atmosphere increases the rate of densening. A period of rest during cooling has no effect on the state of vitrification. The data of Norton and Hodgdon (*Jour. Amer. Ceram. Soc.*, **14** [3] 177–206 (1931)) are discussed. For Part III see *Ceram. Abs.*, **15** [7] 211 (1936). M.V.C.

Colloidal fuel: I. J. L. STREVENS. *Colliery Eng.*, **13** [4] 124 (1936).—This review is devoted mainly to British conditions and the British navy. G.T.

Combustion research with gas burners of different mixing characteristics. M. H. MAWHINNEY. *Ind. Heating*, **2** [4] 192–93 (1935).—Several papers of German origin on this subject are discussed; the principal conclusions are as follows: (1) In the combustion of coke-oven

gas the maximum content of CO in the flue gases is found when the actual air supply is one-half of the theoretical amount of air for complete combustion. (2) The quantity of H_2 in flame and waste gases in almost all cases is equal to or greater than that of CO. (3) The length of flame depends on the extent of mixing gas and air; the more intimate the mixture and the greater the excess of air, the shorter will be the flame. (4) The wall temperature in the furnace has no effect on flame length required for complete combustion. M.H.

Combustion triangle in formation of soot. G. ACKERMANN. *Forschungheft*, No. 366 (1935); abstracted in *Arch. Wärmewirt.*, **16** [2] 47–48 (1935).—With most operations the incompleteness of combustion in cases of excess of air and flue-gas temperatures lower than 700°C can generally be traced to soot formation. To measure the soot and thus the heat wasted quantitatively, A. derived the construction of a new combustion triangle. Applications of the triangle to several solid and liquid fuels is illustrated. The new triangle in comparison with that of Ostwald yields higher waste-heat and lower excess-air values. F.P.P.

Comparative heating methods and efficiences in industrial furnace and oven practice. C. F. MAYER. *Ind. Heating*, **3** [4] 257–62 (1936).—The advantages and disadvantages of various heat applications and the recently developed direct-air heater system, especially in the case of oil as fuel, are described. M.H.

Determination of the excess-air figure, taking into account the unburned carbon. M. S. MASLENIKOF. *Feuerungstechnik*, **24** [1] 7–9 (1936).—Formulas usually used for determining the excess-air figure (α) yield too high values because they do not take into account the unburned carbon and "light coke." A formula is developed permitting the determination of the true α-value. M.V.C.

Distribution of the direction of heat radiation from surfaces. E. SCHMIDT AND E. ECKERT. *Forsch. Gebiete Ingenieurw.*, **6A** [4] 175–83 (1935).—Theoretical considerations are presented and measurements are made of the distribution of heat radiation from surfaces of nonconductors and of metals. The radiation from all types of materials is shown to deviate markedly from Lambert's cosine law. With nonconductors, the radiation declines sharply as the angle between the emitted rays and the normal to the surface approaches 90°, while with metals the radiation increases in this region. Roughening of the surface will permit an approach to Lambert's law. A relative radiation number determined by comparison with a black body along the normal to the surface can not be transformed to total radiation in all directions. With nonconductors the ratio of the radiation number of total radiation to that in the direction of the normal lies between 0.93 and 1, with metals between 1 and 1.3. The nonconductors studied include copper oxide, corundum, paper, clay, glass, and ice. F.P.P.

Dynamics of the stream of flame in tank furnaces. N. N. NORKIN. *Keram. i Steklo*, **12** [2] 22–26 (1936).—Assuming that the laws of motion of a stream of flame are analogous to those of a liquid stream, the functional dependence between factors characterizing the flame stream, such as velocity of motion, inclination angle of flame, length of stretch, and depth of stream, can be determined analytically. Two basic motions of gases occur in a tank furnace: (*a*) parabolic motion with turbulent formations at the boundaries of the stream, and (*b*) a turbulent motion directed toward the crown and from the crown toward the glass surface. Both types of motions must be present in the furnace to complete the combustion reactions which can be obtained by directing the flames at such an angle that the stream of flames will strike the glass surface. M.V.C.

Emission and absorption factor of gases. G. RIBAUD. *Chaleur & Ind.*, No. 177, p. 23 (1935); *Jour. Soc. Glass Tech.*, **20** [78] 93A (1936).—To calculate the heat exchanges by radiation occurring in an industrial furnace, it is necessary to know the emissive and absorption powers of the furnace gases. The attempt was made to fix values for the total emissive power, at different temperatures, of various thicknesses of CO_2 for the band 2.7μ and also for the absorption of CO_2 at different temperatures for various wave-lengths. Correction to this article, *Chaleur & Ind.*, No. 187, p. 514 (1935).

Firing technique at the Leipzig Fair. MANGOLD. *Feuerungstechnik*, **24** [3] 47–48 (1936).—A brief review of new furnaces exhibited at the Leipzig Fair in the spring of 1936 is given. Illustrated. M.V.C.

Fuel economy in the ceramic industry; the economics of pottery firing in tunnel ovens. FELIX SINGER. *Brit. Clayworker*, **45** [529] 44–48 (1936).—A discussion with data on the cost of firing periodic and tunnel kilns with coal, gas, or electric power is given. R.A.H.

Possibilities of convection-type heating equipment. CHAS. E. BUYSSE. *Ind. Heating*, **3** [4] 230–36 (1936).—The advantages of convection gas heating in the various industries and the economies realized by its application are discussed. Almost any heating operation up to 1400°F can be accomplished by this method more uniformly and economically than with other methods. M.H.

Pottery firing in tunnel ovens. FELIX SINGER. Read before National Council of Pottery Ind., Stoke-on-Trent, March, 1936; abstracted in *Pottery Gaz.*, **61** [707] 702–707 (1936). E.J.V.

Practical application of controlled atmosphere furnaces. T. B. BECHTEL. *Ind. Heating*, **3** [4] 221-28 (1936).—Conditions requiring controlled atmosphere in heat-treating furnaces are discussed, and equipment and types of furnaces suitable for such control are described. M.H.

Pulverized fuel firing. "ENTROPY." *Elec. Rev.*, **118** [3047] 561–62 (1936).—Pulverized fuel firing is more suitable than mechanical stokers for low-grade coals only if the term includes coals of small size, those having a high ash content, and washery refuse. Conditions in which the system is most advantageous, its applications, the benefits of air separation, types of pulverizers, and the choice of medium- or high-speed pulverizers are the topics discussed. J.L.G.

Radiation reaction at any point in a furnace cavity. W. J. WOHLENBERG. *Ind. Eng. Chem.*, **28** [6] 698–703 (1936).—A solution of the dynamical processes occurring in the furnace cavity requires evaluation of the radiation reaction as to its net effect at each of several classes of local, or point, zones within the cavity. This involves

an extension of the idea of the radiant mean value, with respect to the point under observation, of conditions affecting the net radiant exchange between the point and the enclosure, including its contents. The classes of required local reference zones are defined, and expressions representing the net exchange by radiation between each of the zones and its surroundings are included. General forms of the expressions apply to any cavity for the conditions stated. Special forms are included which apply to gas, grate, or pulverized coal-fired cavities. Illustrated. F.G.H.

Selection and use of coal for brick and pottery kiln firing. R. F. PAGET. *Claycraft*, **8** [12] 513 (1935).—P. describes British kilns and methods followed in firing various types of ceramic products. For each method discussed the best type of British coal is given. M.C.S.

Temperature in industrial furnaces. Interpretation and use to measure radiant heat flux. H. C. HOTTEL, F. W. MEYER, AND I. STEWART. *Ind. Eng. Chem.*, **28** [6] 708–10 (1936).—The significance of temperature measurements in industrial furnaces is discussed. The true gas temperature has less utility, except in making heat balances, than the uncorrected reading ordinarily obtained with a protected couple; the latter measures the rate at which heat would be transferred if the couple were replaced by a surface at the temperature of the heat sink. An instrument consisting in principle of a pair of oriented thermocouples is shown to be capable of measuring the actual rate of heat flow across any plane in a furnace. The instrument was tested at rates of radiant heat flow across a plane of 5000 to 18,000 B.t.u./sq.ft./hr., with an average error of 4% in eight tests. Its application to a study of uniformity of heat distribution in furnaces is discussed. Illustrated. F.G.H.

BOOK

Heat Calculations for Design and Operation of Furnaces (Wärmetechnische Rechnungen für Bau & Betrieb von Oefen). W. HEILIGENSTAEDT. Verlag Stahleisen, Düsseldorf, Germany. 186 pp. + 13 illustrations. Price 11.50 Rm. Reviewed in *Ind. Heating*, **2** [12] 742 (1935).—Every engineering problem concerning furnaces in the iron and steel industry is dealt with. The theory of heat, heat balance, combustion (with space requirements for combustion), heat transfer, conduction of heat with steady and fluctuating temperatures, heating of the charge in furnaces, and heat interchange in recuperators and regenerators are discussed.

PATENTS

Brick and tile. ALFRED HEUER. Ger. 531,367, April 26, 1935 (Cl. 80c. 17.50); *Chem. Abs.*, **29**, 4914 (1935). Addition to Ger. 464,625. Brick and tile are fired by packing them in an annular kiln which contains the whole of the fuel required, the fuel being strewn in finely divided form between the brick or tile. Deleterious effects due to the presence of $CaCO_3$ and S compounds in the clay are thus avoided. Various details are given.

Ceramic kiln. EVELINE B. UNDERWOOD (heir of John T. Underwood). Can. 356,065, Feb. 18, 1936; *Chem. Abs.*, **30**, 2719 (1936). A kiln has a combustion chamber located below the center of the firing chamber, with a flue extending upward from the combustion chamber to the firing chamber. An annular gas tunnel is located below the firing chamber and communicates with the combustion chamber. Stacks communicate with the bottom of the firing chamber.

Continuous furnace for ceramic products. CHARLES DOUX. Fr. 781,300, May 11, 1935; *Chem. Abs.*, **29**, 6384 (1935).

Electric furnace for firing porcelain. SIEMENS-SCHUCKERTWERKE A.-G. (Carl Buff, inventor). Ger. 624,292, Jan. 16, 1936 (Cl. 21*h*. 15.50); *Chem. Abs.*, **30**, 2719 (1936).

Electric furnace for firing porcelain with means for modifying the atmosphere. SIEMENS-SCHUCKERTWERKE A.-G. Fr. 787,009, Sept. 16, 1935; *Chem. Abs.*, **30**, 832 (1936).

Electric tunnel kiln for firing porcelain. SIEMENS-SCHUCKERTWERKE A.-G. Ger. 626,230, Feb. 22, 1936 (Cl. 80*c*. 5); *Chem. Abs.*, **30**, 3611 (1936).

Electrically heated furnace for firing porcelain. SIEMENS-SCHUCKERTWERKE A.-G. (Carl Buff and Hans Gerdien, inventors). Ger. 610,664, March 14, 1935 (Cl. 21*h*. 15.03); *Chem. Abs.*, **29**, 6009 (1935).

Firing ceramic articles. JOHANNES ANDERSEN. Dan. 49,400, Oct. 15, 1934; *Chem. Abs.*, **30**, 2719 (1936). The articles are moved through a vertical oven during the firing.

Firing kiln for ceramic ware. WILHELM E. SPAETHE. Ger. 622,959, Dec. 10, 1935 (Cl. 80*c*. 2); *Chem. Abs.*, **30**, 3611 (1936).

Flame furnaces for ceramic products. SOC. DES ISOLANTS ET RÉFRACTAIRES. (Frédéric C. Le Coltre, inventor). Fr. 787,619, Sept. 26, 1935; *Chem. Abs.*, **30**, 1198 (1936).

Kiln for firing small articles of porcelain or earthenware. A.-G. BROWN, BOVERI & CIE. Swiss 171,636, Dec. 17, 1934 (Cl. 8*c*.); *Chem. Abs.*, **29**, 5618 (1935).

Kilns for glazing earthenware. KERAMISCHE INDUSTRIE-BEDARFS-A.-G. Ger. 621,508, Nov. 8, 1935 (Cl. 80*b*. 8.15); *Chem. Abs.*, **30**, 2343 (1936). The walls of the kilns, which are exposed to the gases from the salt glaze, are coated with material made by molding and firing a mixture of finely powdered MgO and finely powdered sintered MgO.

Muffle kiln. FRANK M. HARTFORD. Can. 355,123, Jan. 7, 1936; *Chem. Abs.*, **30**, 1966 (1936). Structural details are given.

Muffle tunnel furnace. V. N. MIKHOVSKIĬ. Russ. 38,040, July 31, 1934; *Chem. Abs.*, **30**, 1966 (1936). Construction details are given.

Pottery and like kilns. J. G. MCKEAN AND R. F. JONES. Brit. 446,421, May 13, 1936 (Oct. 29, 1934).

Salt-glazing ceramic ware. KERAMISCHE INDUSTRIE-BEDARFS-A.-G. Ger. 612,571, April 29, 1935 (Cl. 80*c*. 8); *Chem. Abs.*, **29**, 6384 (1935). A kiln is described with an external apparatus for blowing the salt onto the ware being fired in the kiln.

Semi-continuous and continuous kilns of the chamber type. A. GEYER. Brit. 446,936, May 20, 1936 (April 17, 1935).

Shaft furnace, with perforated bottom plate, for making filaments from glass, etc. HUGO KNOBLAUCH. Ger. 626,198, Feb. 21, 1936 (Cl. 32*a*. 25); *Chem. Abs.*, **30**, 3611 (1936).

Tunnel kiln. WARMESTELLE STEIN UND ERDEN G. M. B. H. (Karl Beckenbach, inventor). Ger. 612,524, July 20, 1935 (Cl. 80*c*. 5); *Chem. Abs.*, **30**, 591 (1936). A kiln or furnace for firing earthenware, roasting or sintering ores, etc., is described.

Ware carrier for continuous kilns. F. M. HARTFORD. U. S. 2,041,176, May 19, 1936 (April 13, 1935).

Geology

Comparative X-ray and morphological investigation of andalusite $(AlO)AlSiO_4$, libethenite $(CuOH)CuPO_4$, and adamine $(ZnOH)ZnAsO_4$. H. STRUNZ. *Z. Krist.*, **94** [1] 60–73 (1936).—Lattice constants, number of ions per unit cell, and lattice symmetry were determined for libethenite and adamine. Libethenite, adamine, and andalusite show close relations in their morphology and lattice structure. They are considered as an example of isotypy. H.I.

Composition of clays. ROBERT SCHWARZ AND GEORG TRAGESER. *Z. anorg. allgem. Chem.*, **227** [2] 179–83 (1936).—The authors made dehydration studies on kaolins and found that the composition corresponded to the formula $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$. L.T.B.

Datolite and herderite; isomorphy between silicates and phosphates. HUGO STRUNZ. *Z. Krist.*, **93** [1–2] 146–50 (1936).—The unit cell, space group, and number of mols. in the unit cell of herderite ($Ca(F,OH)BePO_4$) were determined. These correspond so closely with those of datolite ($Ca(OH)BSiO_4$) that the two minerals must be considered as isomorphous. A probable structure for herderite and datolite is proposed. H.I.

Diffusion of water in a zeolite crystal; a contribution to the question of the mobility of adsorbed molecules. ARNE TISELIUS. *Z. Phys. Chem.*, **A169** [5] 425–58 (1934).—The changes in optical properties with the water content or with the content of other adsorbed substances, make possible a direct observation of the diffusion of the adsorbed substances into a dehydrated zeolite crystal. An experimental method is described whereby microscopic observations are possible in vacuum at various temperatures. By this method the diffusion of water into a heulandite crystal was followed. The diffusion constant was measured as was also its dependence on concentration, pressure, temperature, and the direction in the crystal. L.T.B.

Enriching Rhodes chromite. ERNESTO SALMOIRAGHI. *Ann. Chim. applicata*, **25**, 243–54 (May, 1935).—S. reports his experimental enrichment of chromite occurring in the island of Rhodes. The mineral with a 41 to 45% content is commercially utilizable. In Banato chromium enrichment has occurred with 33% of chromium oxide (Cr_2O_3), while in Rhodesia and in the Transvaal, the mineral extracted contained only 2% chromium, but was enriched up to 40 to 42% (under the Table of Wilpley). Enrichment was performed by electromagnetic methods, by calcination, and by polishing, this last being accomplished by the method of Richards (1894), an American mining engineer. S. concludes that Rhodes chromium may be decidedly enriched by such methods and that in testing results from grinding best results obtain with slurry, the diameter of the granules being less than 0.10 mm. and the sterile infiltrate in cracks of the granules being removable only by very "subtle" work. The interest and needs of Italian industries will justify further intensive, enthusiastic study of the chromium-bearing layers of the island. K.R.

Feldspar deposit discovered in gold-rush days commercially developed. W. E. TRAUPPER. *Pit & Quarry*, **28** [10] 51–53 (1936).—The Keystone, S. D., plant of the Consolidated Feldspar Corp. is located in the Black Hills and was built in 1929. The deposit, discovered by a gold prospector, is a pegmatite dike at least 200 ft. deep. A 100-ft. quarry face is now being worked. Details of plant equipment and operation are given. Illustrated. E.J.V.

Kyanite from Prilepec. LJUDEVIT BARIC. *Z. Krist.*, **93** [1–2] 57–92 (1936).—Descriptions of crystallographic and optical properties are given. H.I.

Lineage structure of crystals. M. J. BUERGER. *Z. Krist.*, **89**, 195–220 (1934).—In general, the internal structure of crystals is continuous but branched, the degree of imperfection ranging from dendritic crystals to outwardly single homogeneous crystals. Examples of dendritic structure in single zinc crystals, gas absorption in galena, and presence of water in rock salt are cited. Mosaic structure may account for low values of densities of supposedly perfect crystals. H.I.

Metamorphism in rocks of the granite massif of Eibenstein-Neudek. E. O. TEUSCHER. *Mineralog. Petrog. Mitt.*, **47** [4–5] 273–312 (1936).—The origin of quartz, tourmaline, topaz, mica, cordierite, and andalusite by pneumatolytic action at the periphery of a granite body is described. H.I.

Mixing or unmixing of silicate-rock magmas. G. LINCK. *Chem. Erde*, **10** [1] 126–28 (1935).—The applicability of Grigoriev's experiments (*Ceram. Abs.*, **15** [2] 74 (1936)) on miscibility of silicates to rock magmas is denied. H.I.

Mosaic structure in crystals. H. E. BUCKLEY. *Z. Krist.*, **89**, 221–41 (1934). H.I.

Preparation of brick clay with steam. HERMANN BRENNTROPP. *Tonind.-Ztg.*, **60** [5] 49 (1936).—Experiments showed that sensitive clays treated with steam or hot water change into high-grade clays. The clay is treated with steam under definite pressure. No more water for shaping is required. During the 8-hr. drying the brick lose about 20% of their moisture. The brick have a fine appearance and a structure similar to that of a vitrified brick. M.V.C.

Researches on china clay. R. J. DAVIES, R. A. GREEN, AND H. F. E. DONNELLY. Read before Ceram. Soc., Stoke-on-Trent, April, 1936; abstracted in *Pottery Gaz.*, **61** [707] 699–701 (1936). E.J.V.

Variable composition of cordierite in the Dartmoor granites. A. BRAMMALL AND B. RAMA RAO. *Mineralog. Mag.*, **24**, 257–59 (1936).—Variations in optical properties and in FeO and MgO for cordierite specimens collected from the Dartmoor granite are listed. H.I.

BOOKS AND BULLETINS

Industrial Waters in Canada, Interim Report No. 1. HARALD A. LEVERIN. *Can. Dept. Mines, Mines Branch Pub.* [*Memorandum Series*], No. 64 (1936). 32 pp., mimeographed. L. has analyzed civic waters of all centers of over 3000 population in the industrial areas of Quebec and Ontario. G.M.H.

Magnesite industry in 1935. ANON. *Bur. Mines Mineral-Market Report*, MMS No. 447. 2 pp. Free. R.A.H.

Natural Bonded Molding Sands of Canada. CORRELL H. FREEMAN. *Can. Dept. Mines, Mines Branch Pub.*, No. 767 (1936). 144 pp., 11 figs., 7 drawings, 15 tables. Price 25¢. This report contains chapters on the mode of occurrence and technology of molding sands, physical properties and methods of testing, the status of the Canadian industry, and five chapters on 148 Canadian sands. A glossary of terms used in the foundry industry and a bibliography are given. G.M.H.

Outline of Mineralogy and Petrography (Grundriss du Mineralogie und Petrographie). GOTTLOB LINCK AND HERMANN JUNG. Gustav Fischer, Jena, 1935. 290 pp. Price bound, 16.00 Rm.; unbound, 14.50 Rm. Reviewed in *Sprechsaal*, **69** [10] 143 (1936).—The book is divided into (1) general mineralogy, (2) minerals, and (3) science of rocks. The first part deals with general explanations of crystal forms and symmetry, properties of crystals, their relationship with each other, and their chemical composition and other characteristics. The second part is devoted to mineral groups, their origin, and their conversion and decomposition products. The third part discusses eruptive, sediment, and similar rocks. M.V.C.

Patents on geophysical prospecting issued in the United States, England, Canada, Australia, Germany, France, and Russia. W. AYVAZOGLOU. *Bur. Mines Information Circ.*, No. 6883, 136 pp. Free. Abstracts of 545 patents are given. R. A. HEINDL

Quinquennial Review of the Mineral Production of India for the years 1929 to 1933. DIRECTOR AND SENIOR OFFICERS, GEOL. SURV., INDIA. *Rec. Geol. Surv. India*, **70**, lxxvi + 453 pp. (1935). 7 plates. Price 6/4 Rupees or 10s. There are interesting descriptive chapters on clays, cement, glassmaking materials, magnesite, chromite, kyanite, sillimanite, and other minerals. It is a valuable book of reference. A. P. SOM

Weathering of Rocks and Composition of Clays. ATTI SALMINEN. *Suomalaisen Tiedeakatemian Toimituksia*, **A44** [6] 139 pp. (1935); abstracted in *Chem. Zentr.*, **i**, 2176 (1936).—Phenomena having an effect on the composition of clay deposits are discussed, and the chemical, mineralogical, and mechanical composition of Finnish clays of various deposits are described. M.V.C.

PATENT

Treatment of bentonite. ATOM STUDIENGES. FÜR ERZE STEINE UND ERDEN M. B. H. Ger. 613,037, May 17, 1935 (Cl. 80*b*. 12.01); *Chem. Abs.*, **29**, 5618 (1935). Varieties of bentonite having relatively low swelling, binding, and dispersing capacities are improved by treatment with an aqueous solution of an alkali metal salt, whereby the exchangeable cations (mainly Ca) in the bentonite are replaced by alkali metal. Preferably, use is made of an alkali salt of an acid, the alkaline earth salts of which are water-insoluble.

Chemistry and Physics

Bauxite and mullite, studied by X-rays: II. M. E. NAHMIAS AND G. HÄGG. *Z. Krist.*, **88**, 90–92 (1934).—Samples of heated kaolinite and impure bauxite irradiated with CaK-rays gave powder diffraction patterns of sufficient resolution so that the nature of the free SiO_2 present could be readily determined. Bauxite heated at 1300°C for 3 hours gave the pattern of tridymite. By this method mullite can be readily distinguished from sillimanite. For Part I see *Ceram. Abs.*, **12** [10–11] 376 (1933). H.I.

Cerimetric titration of small amounts of iron by means of *a,a'*-dipyridyl as an indicator. C. J. VAN NIEUWENBURG AND H. B. BLUMENDAL. *Mikrochemie*, **18**, 39–42 (1935).—Among the existing methods the titanometric titration is by far the best, but the necessity of a nearly daily standardization of the dilute $TiCl_3$ solution and the difficulty of storing this liquid out of contact with air presents a serious drawback. In this respect an oxidizing standard liquid is preferable. The authors prepared their indicator solution as follows: 0.25 g. *a, a'*-dipyridyl is dissolved into 50 cc. water, and 50 cc. concentrated NH_3 are added. Some 5 drops of this solution will do for about 50 cc. of the ferrous solution. They were able to titrate ferrous solutions containing from 0.1 to 10 mg. Fe in 50 cc. NHCl by means of 0.002 to 0.015 *N* ceric sulfate in 1 *N* sulfuric-acid solution. The ceric solution, if guarded against direct sunlight, is quite stable, even in these extreme solutions. The writers found it undesirable to use a sulfuric-acid solution of ferrous iron. The color of the pyridyl complexes is far better developed in hydrochloric acid. L.E.T.

Chemical structure of the clay minerals. JULIUS HOLZNER. *Chem. Erde*, **9**, 464–84 (1935).—About 190 analyses of water-containing silicates of aluminum and isomorphous cations, largely microcrystalline or optically isotropic weathering minerals, were recalculated, to show the Si:O relations. About 150 of these lead to the ratio O/Si = 2.5, which is characteristic for silicate lamellar structures. This structure appears to be widespread in "amorphous" and microcrystalline minerals of the upper oxidation zone. The small extent of substitution of Al for Si appears to be characteristic of this type of mineral. These minerals, especially the "amorphous" forms, contain considerable amounts of water in the form H_2O as well as varying quantities of OH. The varying relations of the constituents are explained in part on the basis of simple combinations of silicate and hydroxide lamellas, but the necessity for more complicated relations of these lamellas is pointed out. H.I.

Continuity of the solid and the liquid states. J. FRENKEL. *Nature*, **136** [3431] 167–68 (1935).—F. believes that there is no fundamental difference between the solid and liquid states but that they are connected in a continuous way just as are the liquid and gaseous states. He explains that the sharp transitions (melting or boiling)

are substitutes for continuous transitions through unstable intermediate states, corresponding to the hook-like parts of the p-v curve which under certain conditions can be made to disappear. A detailed mathematical treatment is promised for the near future. J.L.G.

Crystal morphology of quartz: I, The vicinal phenomena of quartz and their importance in the recognition of interpenetration twins after Dauphinee and Brazilian laws. G. KALB. *Z. Krist.*, **86**, 439–52 (1933). **II, Crystal morphology of α-quartz (high quartz).** *Ibid.*, 453–57. **III, Morphological constants of β-quartz.** *Ibid.*, 458–65.—The characteristics of vicinal faces and twinning in low- (β) quartz and of intergrowths in high- (α) quartz are described and their importance in geologic thermometry and the determination of crystal succession are evaluated. **IV, Morphology of quartz in relation to mineral genesis.** *Ibid.*, **90**, 163–85 (1935). H.I.

Crystal structure of magnetic ferrioxide, γ-Fe_2O_3. GUNNAR HÄGG. *Z. Phys. Chem.*, **B29** [2] 95–103 (1935).—X-ray studies have shown that if, during the oxidation of Fe_3O_4 at low temperatures, the spinel structure is retained until γ-Fe_2O_3 is formed, there is a gradual decrease in elementary dimensions of the crystal. The length of the elementary cell of Fe_3O_4 is 8.380 and that of Fe_2O_3 is 8.322Å. From the changes in the intensities of the X-ray lines and from the changes in the density, it can be shown that the increase of O-concentration during oxidation is caused by the occurrence of vacant positions in the atomic-iron lattice of the spinel phase. In γ-Fe_2O_3 where the O-concentration reaches its maximum, $^1/_9$ of the original iron-atom positions are unoccupied and the elementary cell therefore contains a mean of $21^1/_3$ Fe + 32 O atoms. L.T.B.

Current potential in ceramic diaphragms in barium-chloride solutions. J. BABROVSKY AND B. BÜRGL. *Arhiv za Hemiju i Farmaciju*, **8** [1] 1–7 (1934).—Current potential diminishes asymptotically with an increasing concentration of barium chloride from −53.2 mv. to <0.005 *N* barium chloride. Effects obtained are found to be in agreement with the Helmholtz-Smolachowski theory. E.J.V.

Detection of barium, strontium, and calcium. N. A. TANANAEV. *Z. anal. Chem.*, **100**, 391–94 (1935).—The anhydrous chlorides and nitrates of calcium and magnesium are soluble in glacial acetic acid but, of the corresponding barium and strontium salts, only strontium chloride is dissolved. Acetic acid is similar to absolute alcohol in its behavior as a solvent, in this respect. Therefore, it can replace alcohol in qualitative analysis. If the nitric acid solution of the precipitate produced by ammonium carbonate and alcohol is evaporated to dryness and the anhydrous residue is digested with glacial acetic acid, only magnesium and calcium ions will pass into solution. Various ways in which the Kann tests for calcium, magnesium, strontium, and barium can then be made are outlined. E.J.V.

Detection of cadmium selenide. P. KRUMHOLZ AND O. KRUH. *Mikrochemie*, **17**, 210–14 (1935).—For the detection of cadmium in the systematic analysis, cadmium sulfide is precipitated from an ammonia-cyanide solution. In the presence of copper salts a yellow precipitate is formed which may erroneously be taken for cadmium sulfide. Therefore selenide was tried for precipitation. Cadmium selenide has an intense reddish brown color. The paper deals with the following subjects: (1) detection of cadmium, (2) detection of cadmium in the presence of copper, and (3) and (4) detection of cadmium in the presence of nickel, cobalt, and zinc. Method 1 is described as follows: To 2 cc. ammonia-alkaline, ammonium-salts solution a drop of 25% potassium cyanide solution is added. Then 5 drops of a reagent solution is added. The mixture is boiled. The reagent solution is made up from 1 g. sodium selenide dissolved in a small amount of hot water, to which water is added to make 100 cc. solution; 0.5 cc. of potassium cyanide is added, and the filtered solution is kept in sealed bottles in a dark room for a few days. The cadmium-selenide test solution is cooled and 1 cc. ether is added. The reddish brown layer of cadmium-selenide appears which stands out against a white background. L.E.T.

Determination of alumina in manganese ore. M. SEKINO. *Bull. Inst. Phys. Chem. Research Japan*, **14**, 1241–45 (1935); *Brit. Chem. Abs.-B.*, **55** [11] 232 (1936).—Precipitation of the basic acetate is complete from solutions of p_H 5.2 to 5.6.

Determination of small amounts of potassium by means of silver cobaltinitrite. R. J. ROBINSON AND G. L. PUTNAM. *Ind. Eng. Chem., Anal. Ed.*, **8** [3] 211–13 (1936).—When a 10% acetic acid medium is used in the Greiss method for the determination of nitrite, Beer's law is valid over a wide range. Since the intensity of the color is somewhat dependent upon the time interval between the addition of the sulfanilic acid and 1-naphthylamine, the accuracy of the method is improved by mixing the reagents before use. The Tischer method for potassium is not applicable to the determination of less than 0.120 mg./ml. of solution. Somewhat less than 0.080 mg./ml. may be determined if comparison is made with potassium standards that have been given an identical treatment. By precipitating from a 30 volume-per cent alcoholic medium at 4° to 6°C, the minimum quantity of potassium determinable may be decreased to about 0.003 mg./ml. of solution. By employing a silver cobaltinitrite precipitating reagent and running potassium standards simultaneously, the minimum quantity of potassium determinable is reduced to about 0.002 mg. Precipitation should be allowed to take place near 0°C, and an acetone wash liquor used. This method was found to be applicable to the determination of potassium in fresh water. F.G.H.

Determination of sulfate; An attempt to determine sulfate by titration with lead nitrate, using eosin as indicator. J. E. RICCI. *Ind. Eng. Chem., Anal Ed.*, **8** [2] 130–32 (1936).—From 0.10 to 0.25 gram of sodium sulfate may be determined by direct titration with 0.1 *M* lead nitrate solution in a total (final) volume of 30 to 40 cc., using 12 drops of 0.5% eosin as indicator. The solution to be titrated must be neutral. The best results are obtained in the titration of about 0.15 to 0.20 gram of sodium sulfate and with the use of a reference color. The determination is then accurate to about 0.0005 gram of sodium sulfate. The presence of 1 gram of alkali nitrate or 2 grams of alkali chlorate does not interfere. F.G.H.

Determination of thorium with picrolinic acid and 8-hydroxyquinoline. F. HECHT AND W. EHRMANN. *Z. anal. Chem.*, **100**, 87–103 (1935).—It has been shown

that lead and calcium can be determined accurately with picrolinic acid. Thorium forms a less soluble salt with this acid which contains only 17.82% thorium. While it is not possible to separate thorium from the other rare earths with this reagent, after precipitating thorium as the white, hydrated peroxide by treatment with ammonium nitrate and hydrogen peroxide, the precipitate can be dissolved in nitric acid and is then ready for treatment with picrolinic acid, the recommended strength being a solution of 2.64 g./liter. The thorium solution should be free from ammonium salts. For 10 mg. of thorium in a volume of 55 to 60 cc. in the presence of 2.5% acetic acid by volume, 50 cc. of the picrolinic acid reagent should be used. A precipitate of $Th(C_6H_6ON)_4 \cdot C_6H_7ON$ can be obtained in an acetic acid solution buffered with ammonium acetate. This precipitate is suitable for both macro- and microdetermination of thorium. The procedure used is simpler and more rapid than the picrolinic acid method.

E.J.V.

Direct titration of sulfates; further studies with tetrahydroxyquinone as an internal indicator. R. T. Sheen and H. L. Kahler. *Ind. Eng. Chem., Anal. Ed.*, **8** [2] 127–30 (1936).—The direct titration method for determination of sulfates with the use of tetrahydroxyquinone as an internal indicator is described. Sulfates can be determined by this method up to 30,000 p.p.m. Phosphates up to 60 p.p.m. can be eliminated by p_H control. Isopropyl alcohol is found to be as satisfactory as ethyl alcohol for reducing solubility of barium sulfate and hastening the precipitation. The use of sodium chloride to sharpen the end-point in concentrations above 2000 p.p.m. of sulfate is described. Results obtained by this method check gravimetric analyses within an average of 3%. Comparison of results with the Betz-Hellige method is given. F.G.H.

Equilibrium diagram of the system $CaO \cdot Al_2O_3 \cdot 2SiO_2$–$CaO \cdot TiO_2$. Usaburo Nisioka. *Sci. Repts. Tôhoku Imp. Univ.* [*Series 1*], **24** [5] 707–13 (1936).—This system, anorthite–perovskite, was studied by quenching, and the samples were examined with a metallurgical microscope after etching in 2% HF. There is a simple eutectic at 1350° and 35% $CaO \cdot TiO_2$ by weight. Supplementary work on the system $2CaO \cdot Al_2O_3 \cdot SiO_2$–$CaO \cdot TiO_2 \cdot SiO_2$, gehlenite-titanite shows that quenching mixtures of these two gives probably gehlenite, perovskite, and glass.

W.D.F.

Equilibrium diagram of the system $CaO \cdot MgO \cdot 2SiO_2$–$CaO \cdot TiO_2$. Usaburo Nisioka. *Sci. Repts. Tôhoku Imp. Univ.* [*Series 1*], **24** [5] 714–18 (1936).—This system, diopside–perovskite, was studied by quenching specimens and examining them with a metallurgical microscope. This system has a simple eutectic at 1270° and 32% $CaO \cdot TiO_2$ by weight. W.D.F.

Fluorine and its compounds. A. Damiens. *Bull. soc. chim.* [France], [5] **3**, 1–22 (1936); abstracted in *Chem. Zentr.*, **i**, 2519 (1936). M.V.C.

Fourier analysis of X-ray patterns of vitreous SiO_2 and B_2O_3. B. E. Warren, H. Krutter, and O. Morningstar. *Jour. Amer. Ceram. Soc.*, **19** [7] 202–206 (1936).

Heat content and lattice condition of active magnesium oxide. R. Fricke and J. Lüke. *Z. Elektrochemie*, **41** [3] 174–83 (1935).—Magnesium oxide, prepared by the dehydration of magnesium hydroxide, is richer in energy, the shorter the heating period and the lower the dehydration temperature. One of the prepared "active" magnesium oxides showed about 2.7 kg.-cal./mol. more than the ordinary value. A pronounced lattice dilation is also noted in these cases on X-ray analysis. Measurements of intensity indicate random disorientation of the energy-rich preparations. The size of the magnesium oxide crystals appears to have no connection with the observed differences in total energy. Numerous literature references of the equilibrium $Mg(OH)_2$–$MgO \cdot H_2O$ are discussed in view of the present findings. E.J.V.

Infra-red absorption spectra of quartz and fused silica from 1 to 7.5 μ: I, Experimental method. D. G. Drummond. *Proc. Roy. Soc.* [London], **153**, 318–27 (1936).—A comprehensive experimental survey is attempted for the absorption spectra of fused silica and of the ordinary and extraordinary rays in quartz over the whole region from 1 to 7.5 μ. The apparatus is described, and the precautions necessary to secure the attainable accuracy are indicated. **II, Experimental results.** *Ibid.*, 328–39 (1936).—Results are given in graphical form for absorption measurements on a wide range of thicknesses of specimens.

A.P.

Lattice constants for the year 1936. M. C. Neuburger. *Z. Krist*, **93** [1–2] 1–36 (1936). H.I.

Lattice shrinkage and structure of montmorillonite. G. Nagelschmidt. *Z. Krist.*, **93** [6] 481–87 (1936).—The relation of the degree of dehydration of montmorillonite to the $d_{(001)}$ spacing was investigated. The results obtained can be explained by assuming that the first 4 molecules of H_2O enter between the layers of the structure whereas the bulk of the next 10 molecules remain at the surface of the crystals. H.I.

Melting diagrams of boric anhydride and sodium metaborate melts. Ernst Jenckel. *Z. anorg. allgem. Chem.*, **227** [2] 214–20 (1936).—Melting-point curves were determined in the portion of the system Na_2O–B_2O_3 from 12% Na_2O to 47% Na_2O. L.T.B.

New form of crystalline quartz at −183.5°C. Harold Osterberg. *Phys. Rev.*, **49** [7] 552–53 (1936).—When *X*, *Y*, and specially oriented *Y* cuts of quartz crystals encased in an air-tight brass crystal holder were subjected to low temperatures, they ceased abruptly to oscillate piezoelectrically near the boiling point of liquid air. By immersing the crystal holder in liquid oxygen boiled under reduced pressure, the temperature at which α-quartz is transformed to the nonpiezoelectric form, called δ-quartz, was found to be −183.5°C. Changes in the optical rotatory power at the transition were noted and measured but these were sluggish as compared with the rapid piezoelectric changes. Changes in volume must be small since quartz can be plunged in liquid air without damage. Assuming that δ-quartz belongs to the hexagonal system, the loss of piezoelectric property is interpreted to mean that it falls among classes 9, 12, 21, or 24 (Voight) or 24, 25, 30, or 32 (Schoenflies). Of the four types of crystalline quartz (α, β, γ^4 and δ), γ and δ are nonpiezoelectric. J.L.G.

New reagent for potassium: I, Qualitative. A. W. Clark and C. O. Willits. *Ind. Eng. Chem., Anal. Ed.*, **8** [3] 209–10 (1936).—A 2% solution of naphthol yellow S, used in the ratio of 3 ml. of reagent to 10 ml. of test solution,

is recommended for general use as a test for potassium. For test solutions containing less than 0.79 mg. of potassium per ml., 3 ml. of a 5% solution of the reagent to 10 ml. of test solution should be used. This necessitates running a blank. The reagent will detect 1 part of potassium in 2500 parts of solution. The presence of sodium does not interfere with the test but does increase the length of time before precipitation occurs. Ammonium and other cations commonly associated with potassium do not interfere with the test. F.G.H.

One-piece glass micro-Kjeldahl distillation apparatus. P. L. KIRK. *Ind. Eng. Chem., Anal. Ed.*, **8** [3] 223–24 (1936).—Numerous improvements in the usual type of glass-distillation apparatus used for nitrogen determination are described and illustrated. F.G.H.

Periodic table. H. H. STEPHENSON. *Chem. & Ind.*, **55** [10] 199–200 (1936).—The 92 chemical elements are arranged in 8 families of 9 generations to make a closed table of 72 spaces without gaps. H.H.S.

Permeability of compacted powders. Determination of average pore size. R. N. TRAXLER AND L. A. H. BAUM. *Physics*, **7** [1] 9–14 (1936).—With air as the diffusing medium, a method and apparatus have been developed for measuring the permeability of compacted, unconsolidated powders. A formula is given for calculating the average pore diameter from the permeability and the percentage of voids in the compacted powder. By establishing a simple relationship between the degree of packing (as measured by the percentage of voids) and the average individual pore diameter, it is possible to calculate the pore size in a comminuted solid for any degree of compaction. When liquids, *e.g.*, bitumen, sulfur, etc., are stabilized by the addition of solid particles, the degree of packing of the particles and the dimensions of the films and masses of liquid separating them exert a profound influence on the consistency of the mixture. Thus, a knowledge of the average pore diameter of a powder as present in a solid-liquid system is of practical value. The influence of average particle size on average pore diameter was studied and data are presented for silica and slate powders.

Potassium borates: system B_2O_3–K_2O. A. P. ROLLET. *Comp. rend.*, **200**, 1763–65 (1935).—Mixtures of B_2O_3 with K_2O have a strong tendency to form glasses and require up to 10 days for complete crystallization. Mixtures with 7 to 20% K_2O do not crystallize even after very long periods. Up to 6% K_2O, no crystallization whatsoever takes place even after several weeks of annealing. The thermal analyses are described in detail, and the complete equilibrium diagram of the system B_2O_3–K_2O was established. M.H.

Precipitation of titanium as phosphate. T. DA-TSCHANG AND LI HOUONG. *Compt. rend.*, **200**, 2173–75 (1935).—A method is described to precipitate Ti from acid solutions by ammonium phosphate. For complete precipitation, the ammonium-phosphate solution must have at least 10% concentration except for acidities less than 1 to 5%. M.H.

Pyrophosphate method for determining zinc. Z. H. PAN AND C. H. CHIANG. *Jour. Chinese Chem. Soc.*, **3** [2] 118–21 (1935); *Jour. Soc. Glass Tech.*, **20** [78] 142A (1936).—The conversion of zinc ammonium phosphate into zinc pyrophosphate begins at 350° and is completed in 2 hours at 370°; temperatures up to 520° produce little volatilization. The temperature usually recommended (900 to 1000°) is unnecessarily high and leads to volatilization.

Quantitative separation of nickel and cobalt. E. RAYMOND. *Compt. rend.*, **200**, 1850–52 (1935).—The use of triethylolamine [$(CH_2OHCH_2)_3$] permits a simple and exact separation of the two metals by precipitation of metallic hydrates which later dissolve again giving a violet liquid for Co and a blue one for Ni. The procedure is described in detail. M.H.

Reactions in the solid state at higher temperatures: XI, Reaction between calcium oxide and silicon dioxide. WILLIAM JANDER AND ERNA HOFFMAN. *Z. anorg. allgem. Chem.*, **218** [2] 211–23 (1934).—The reactions of lime and silica as they depend on time and thoroughness of mixture were studied in mixtures of the following molecular proportions: $4CaO:1SiO_2$, $3CaO:1SiO_2$, $1CaO:1SiO_2$, and $1CaO:2SiO_2$. X-rays and chemical analyses were used to follow the reactions. The experiments were carried out at 1200°. In the molecular mixtures 4:1 and 3:1, $2CaO{\cdot}SiO_2$ was formed principally. On long periods of heating, $3CaO{\cdot}SiO_2$ was formed, which is in contradiction to some other investigators. In the 1:1 mixture, $2CaO{\cdot}SiO_2$ forms first of all; it disappears on longer heating and $CaO{\cdot}SiO_2$ forms. In the mixture 1:2, $2CaO{\cdot}SiO_2$ is formed first but in smaller amounts than in the 1:1 mixture. In all of the mixtures at 1200°, $2CaO{\cdot}SiO_2$ is the first reaction product. The reaction between CaO and SiO_2 in the ratio 1:1 was then followed in a dry atmosphere at 1000° after mixing the materials for $2^1/_2$ hours. The first products of reaction were $2CaO{\cdot}SiO_2$ and $3CaO{\cdot}2SiO_2$; on long heating the reaction proceeds to $CaO{\cdot}SiO_2$. At the same temperature but in the presence of water-vapor the reactions become more rapid than in the dry atmosphere. **XIII, The course of reaction during the formation of the Mg-, Sr-, and Ba-silicates.** WILHELM JANDER AND JOSEF WUHRER. *Ibid.*, **226** [3] 225–47 (1936).—Experiments showed that at temperatures between 920° and 1170° the alkaline earth orthosilicates form first of all on the reaction of the oxides in mixtures of the proportions 2:1 and 1:1. Data are included which show the percentage of orthosilicate formed with increasing length of time of heating. For Parts IX–X see *Ceram. Abs.*, **14** [11] 294 (1935). L.T.B.

Reactivity of red or yellow lead oxide with silicon dioxide. J. ARVID HEDVALL AND A. ELDH. *Z. anorg. allgem. Chem.*, **226** [2] 192–96 (1936).—Red PbO and SiO_2 were mixed in the proportion $1PbO:1SiO_2$ and heated at various temperatures up to 650°C. The percentage reaction of the components was determined by analysis. L.T.B.

Researches on adsorption electrodes: I, The glass electrode. H. J. C. TENDELOO. *Proc. Akad. Sci. Amsterdam*, **37** [4] 212–15 (1934).—It is well known that glass acts as a hydrogen electrode and that the deportment of a hydrogen electrode begins to show deviations if concentrated solutions of the salts of potassium and sodium are used; the glass then acts as if it were a potassium or sodium electrode. It is also known that the metal ions in silicates, *e.g.*, in zeolites, are exchangeable by other ions. T. carried out researches to determine if, by exchanging as many as possible of the cations present in the capillary layers of glass by a similar ion, the glass might function as an electrode for that ion; particularly if a glass mem-

brane treated with solutions of calcium chloride would behave as a calcium electrode. The results showed that it is possible to make a glass membrane function as a calcium electrode if the exchangeable ions present in the glass are replaced by calcium ions. L.T.B.

Separation of stannic oxide from various oxides by ignition with ammonium iodide; application to analytical purification of ignited stannic oxide. E. R. CALEY AND M. G. BURFORD. *Ind. Eng. Chem., Anal. Ed.*, **8** [2] 114–18 (1936).—When mixed with a suitable excess of powdered ammonium iodide and heated at temperatures between 400° and 500°C, stannic oxide is quantitatively transformed into stannic iodide and can thus be completely volatilized. This behavior can be used as the basis of analytical procedures for the separation of stannic oxide from most other metallic oxides likely to be associated with it, since these are not affected by such treatment or are converted more or less completely into nonvolatile iodides which can be transformed back to oxides. For example, impure ignited tin oxide, such as that resulting from the nitric acid treatment of common nonferrous alloys, may be corrected for impurities in this way. The experiments show that this method of separation is simple, rapid, and accurate. F.G.H.

Simple method for demonstrating and measuring approximately the index of refraction of crystalline substances for X-rays. H. C. HOYT AND GEO. A. LINDSAY. *Phys. Rev.*, **49** [7] 498–501 (1936). J.L.G.

Simple methods for detection of molybdenum, lead, and cobalt in minerals and rocks. H. LEITMEIER AND F. FEIGL. *Mineral. Petrog. Mitt.*, **47** [4–5] 313–27 (1936).—A red-violet coloration with potassium xanthogenate is specific for Mo. The reaction of PbO with an acetic acid-benzidine solution with the formation of a deep blue oxidation product serves for a quick detection of Pb in minerals. Cobalt in the presence of nickel and iron can be detected by the formation of double rhodanides of Co with alkali rhodanides which are soluble in ether and ethyl alcohol with blue coloration. The methods are described in detail. H.I.

Size determination with the haemacytometer. C. R. AMBERG. *Jour. Amer. Ceram. Soc.*, **19** [7] 207–208 (1936).

II, Sterilization effects on properties of clays. D. R. BAKER AND D. P. GLICK. *Jour. Amer. Ceram. Soc.*, **19** [7] 209–12 (1936); for Part I see *ibid.*, [6] 169–75.

Stress analysis by X-ray diffraction. C. S. BARRETT AND M. GENSAMER. *Physics*, **7** [1] 1–8 (1936).—A mathematical analysis is presented for the problem of determining stresses in a metal by X-ray diffraction. The treatment is a general one, including as special cases the various methods for the determination of uniaxial stresses or the sum of two principal stresses in the plane of the metal surface. The analysis is extended to the problem of determining the two principal stresses individually. Methods are proposed by which these stresses may be determined with an accuracy calculated to be of the order of 1300 lb./in.^{2} for iron and 320 lb./in.^{2} for Duralumin under the best conditions. Camera design, exposure technique, and the applicability of the method to practical problems are discussed.

Structures of the ilmenite type. E. POSNJAK AND T. F. W. BARTH. *Z. Krist.*, **88**, 271–80 (1934).—A study of the system Fe_2O_3 (hematite)–$FeTiO_3$ (ilmenite) shows that a complete series of solid solutions exists between the two components. In the system $FeTiO_3$–Ti_2O_3 there is no evidence of complete solid miscibility. Changes in the unit-cell dimensions, the axial angles, and the specific volume in the system Fe_2O_3–$FeTiO_3$ are shown graphically. Cadmium titanate, when formed below 1050°C, crystallizes with the ilmenite-type structure. At higher temperatures it changes to a modification which has a structure of the perovskite type which does not invert on cooling. Powder X-ray spectrograms of $NiTiO_3$, $CoTiO_3$, $MnTiO_3$, and $MgTiO_3$ indicate that all have structures of the ilmenite type. H.I.

Studies on the quaternary system CaO–MgO–2CaO·SiO$_2$–5CaO·3Al$_2$O$_3$. H. F. MCMURDIE AND HERBERT INSLEY. *Jour. Research Nat. Bur. Stand.*, **16** [5] 467–74 (1936); R. P. 884. Price 5¢.—The phase relations of mixtures of MgO, CaO, Al_2O_3, and SiO_2 with the limited quaternary system in which Portland cement occurs have been worked out. No quaternary compounds or evidence of solid solutions were encountered. The addition of MgO to the ternary system CaO–C_2S–C_3A_3 in amounts of 5% or less causes a shift in the boundary curves away from the CaO apex. MgO is the primary phase in some compositions containing as little as 5% and in all mixtures containing over 33%. R.A.H.

Vapor pressure and thermal dissociation of orthoboric acid. S. BEZZI. *Gazz. chim. ital.*, **65** [7] 766–72 (1935).—The vapor pressure was determined dynamically at various temperatures and found to be independent of the water in the gas. The equilibrium of the system at different temperatures is $H_3BO_3 \rightleftarrows HBO_2 + H_2O$. M.H.

Viscosity measurement. W. PHILIPPOFF. *Arch. tech. Messen*, **5** [58] T49–50 (1936).—The nature of viscosity of a substance and the principles of measuring it are explained; dynamic, kinetic, and relative viscosity, and fluidity are distinguished. Dynamic viscosity, μ, is measured in poise (P); 1 P = 1 dyne sec./cm.^{2} Kinetic viscosity is $\nu = \mu/\delta$, where δ = density in g./cm.^{3} and is measured in stok, 1 st. = 1 cm.^{2}/sec. M.H.

BOOKS

Colloidic (Kolloidik). A. VON BUZAGH. Theodor Steinkopff, Leipzig, 1936. 323 pp.—Price 15 Rm. An introduction to the problems of modern colloidal science. The term "colloidic" is a collective word for the chemistry and physics of colloids and was first used by K. Spiro. The book deals with (1) bases of modern colloidic, (2) disperse and difform systems, (3) significance of colloids in the study of matter, (4) character of colloidal dimensions, (5) morphology of difform and disperse systems, (6) aggregates, (7) adsorption, (8) colloidal changes of state, and (9) changes in the inner state of colloids.

M. V. CONDOIDE

Crystal Chemistry. O. HASSEL. Translated by R. C. EVANS. William Heinemann, Ltd., London, 1935. xi + 94 pp. Price 6s. Reviewed in *Chem. & Ind.*, **55** [18] 349 (1936). See *Ceram. Abs.*, **13** [8] 225 (1934).

Thermal reduction of Al_2O_3 and MgO with C in an electric arc: I, Energy of formation of MgO and its reduction with C; II, Reduction of Al_2O_3 with C in an electric arc. J. HARTNAGEL. Dissertation, Tech. Hochschule, Zurich, 56

pp. (1934); *Helv. Chim. Acta*, **17** [5] 1372–89 (1934); abstracted in *Referat. Silikatliteratur*, No. 2303 (1936).

M.V.C.

PATENTS

Alkali titanates. Titangesellschaft m. b. H. Fr. 779,422, April 4, 1935; *Chem. Abs.*, **29**, 5609 (1935). An O compound of Ti, *e.g.*, calcined TiO_2, is mixed with an alkali hydroxide and heated to below the freezing point of the alkali compound used.

Electrochemical treatment of clay. Giovanni Rodio. Brit. 432,253, July 23, 1935; *Chem. Abs.*, **30**, 395 (1936). Clayey soil is hardened by passage of an electric current from an electrode of Al to one of Cu, Fe, or other metal, preferably a metal widely separated from Al in the electrochemical series.

Lowering the water adsorption of clay. K. S. Zatzepin and G. G. Brodersen. Russ. 35,648, March 31, 1934; *Chem. Abs.*, **29**, 8270 (1935). The water adsorption is lowered by adding to the clay admixed with a tanning solution and water, about 4 to 5% Portland cement.

Process for producing zinc oxide. Emanuel Feuer and Paul Kemp ("Smelting" Metallurgische und Metallwerke A.-G.). U. S. 2,041,237, May 19, 1936 (Oct. 10, 1931). The process for producing zinc oxide comprises charging metallic zinc into a vaporization chamber containing an atmosphere of hot gases substantially free of all constituents capable of reacting with or oxidizing the metallic zinc, whereby the latter is vaporized, and effecting combustion of the evolved zinc vapors in a chamber contiguous to the vaporization chamber.

Production of the borates of zinc, tin, or copper. L. Ferri. Brit. 446,373, May 13, 1936 (June 7, 1934).

Production of manganese dioxide. C. S. Vadner. U. S. 2,042,814, June 2, 1936 (March 2, 1931). The process of producing manganese dioxide comprises calcining manganic-dioxide-dihydroxide in the presence of moist air whereby an oxide of varying contents of manganese dioxide is obtained.

Production of titanium dioxide. B. W. Allan. U. S. 2,040,823, May 19, 1936 (June 22, 1934). (1) The method of accelerating hydrolysis of titanium salt solutions comprises adding thereto a gel of titanium oxide. (8) A seeding agent for accelerating the hydrolysis of titanium salt solutions comprises a gel of titanium oxide prepared by adding to a solution containing titanium, other metal, and sulfate ions, just sufficient caustic soda to combine with all the sulfate present as free acid and combined with titanium, whereby a dry gel is formed.

Quantitative spectroscopic analysis and apparatus therefor. E. J. Martin (General Motors Corp.). U. S. 2,043,053, June 2, 1936 (Aug. 29, 1932). The method of quantitative spectroscopic analysis comprises the following steps: causing the material to emit light; producing the spectrum of the material; recording on a photographic plate a portion of the spectrum including a line of the unknown element and a reference line; graduating the time of exposure throughout the length of each of the lines in steps of known ratio so as to graduate in like manner the quantity of light to which each portion is subjected; measuring the opacities of the different portions of the reference line to obtain a scale of opacities in terms of light quantities; measuring the opacity of a portion of the line of the unknown; evaluating the same in terms of light quantities by reference to the scale; setting up a ratio of the light quantities forming corresponding portions of the line of the unknown and of the reference line; repeating the process with a series of standard electrodes containing the same kind of material but having the unknown element varied in known amount; evaluating the ratio of light quantities obtained from the unknown in terms of percentage of the substance by comparison with ratios of light quantities obtained from the standard series.

Zirconia. Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey (Henri George and Roger Lambert, inventors). Fr. 44,673, March 20, 1935; *Chem. Abs.*, **29**, 6376 (1935). Addition to 762,066 (*Ceram. Abs.*, **13** [10] 279 (1934)). Na_2CO_3 is added to the ground mixture of zircon and vitreous SiO_2, the product is fritted and washed with water, and the operation is completed by treatment with HF.

General

Building code and new materials of construction. R. P. Miller. *Ind. Eng. Chem.*, **27** [10] 1120–22 (1935).—In preparing building codes the aims, (1) toward insuring better construction by statutory compulsion than is actually necessary to secure public safety and (2) of making the building code a specification for good construction, prescribing in detail just how the various types shall be designed and executed in the field, act as deterrents to the development of new materials and methods. Two things are necessary for a satisfactory relationship between building codes and new materials: (1) convincing and reliable information regarding the sufficiency of the material to meet the requirements of its field of application and (2) a broad enough provision in the building law to permit, without undue delay, the use of the new material upon submission of satisfactory proof. The important function of testing new materials may be performed by laboratories of established reputation and the results may be accepted by building officials upon presentation of authentic reports from these laboratories. To pass intelligently on applications for the admission of new materials, the building official should have a sound technical training and a definitely ethical temperament. F.G.H.

Clay products in Australia. Anon. *Clay Prod. Jour. Australia*, **3** [6] 1–2; [7] 9 (1936).—At the annual meeting at Adelaide of the Clay Products Assn. of Australia, the major questions discussed were: (1) imports from Japan over a 50% tariff wall and from Britain over a 12½ to 20% tariff, the imports from Japan being chinaware and from Britain earthenware, sanitary ware, etc; (2) competition of other interests such as cement, steel, bitumen, etc.; (3) competition of government-owned factories; and (4) federal and state taxation. H.H.S.

Commercialism and industry. J. F. Thorpe. *Jour. Proc. Inst. Chem.*, pp. 129–37 (April, 1936); *Bull. Brit. Non-Ferrous Metals Research Assn.*, No. 87, p. 23 (May, 1936).—A plea for the greater permeation of industry by science and for the importance of research is made.

James Pass. RICHARD PASS. *Bull. Amer. Ceram. Soc.*, 15 [6] 220–23 (1936).

New regulations for mine police in anthracite coal areas in Germany. SCHURMANN. *Zentr. Gewerbehyg. Unfallverhütung*, 22, 164 (Aug.-Sept., 1935).—S., silicosis expert (Stettin), comments on the new regulations for mine-police (*Glückauf*, p. 773 (1935)) in hard-coal areas (upper Breslau, Bonn, Dortmund), showing emphatic instructions for the technical security of industrial workers, who must be safeguarded in every possible way from mechanical injuries, from customary illness, and from occupational diseases. The campaign against silicosis through prevention of dust in boring operations is particularly provided for.

K.R.

Organization and work of laboratories for the study of ceramic materials in France. W. DE KEYSER. *Verre & Silicates Ind.*, 7 [10] 116–19 (1936).—The essential points of the organization of the Institute for French Ceramics and the Official Laboratory of the Syndicate of Manufacturers of Ceramic Products in France are discussed briefly.

M.V.C.

Silicosis and the minerals causing it. E. L. MIDDLETON AND W. R. JONES. *Foundry Trade Jour.*, 52 [969] 191–92 (1935).—Silicosis was discussed before the Southern Section of the Institute of Vitreous Enamelers in London. M. (Medical Inspector of Factories) dealt with the disease itself and J. discussed the minerals which cause it.

H.E.S.

Silicosis prevention in the porcelain industry. HARTMANN. *Zentr. Gewerbehyg. Unfallverhütung*, 22, 141–50 (Sept., 1935).—Closely descriptive pages on porcelain manufacture told in narrative sequence deserve a separate abstract. The entire paper carefully translated would make good required reading for pottery amateurs or ceramic apprentices. Dust dangers unload with the masses of raw material, rich in silica and its compounds. The worker may be safer by dampening down the dusts or sucking it away at the point of origin. Here Hartmann, as engineer, asserts himself. Actual pictures are reproduced from holes, corners, floors, and ceilings, showing desirable and undesirable appliances and place-location of workers; ventilators below that should be above, or else in reverse activity. The 1934 protective regulations of the Engineering Insurance Assn. are submitted like solemn commandments. Hartmann emphatically urges ceramic cleanliness. Floors, machines, ceilings, the air itself, can not be too often cleansed, scrubbed, wiped, polished, ventilated, or blown away, to suit his ceramic-medical ideal. As he contemplates continuous droppings and scatterings from beginning to end of the work-cycle, arising and re-arising in ever finer and drier dust-clouds, whirling as in a dance of death, he almost shouts above the roar and clatter, "Ceramic dust is *not* Fate—it is criminal slovenliness."

K.R.

Swedish Commission visits Germany. ANON. *Zentr. Gewerbehyg. Unfallverhütung*, 22, 204 (Nov., 1935); also in *Aertzl. Sachver. Ztg.*, 41, 324 (Dec. 1, 1935).—A Swedish delegation from the Royal Insurance Society toured Germany to study research methods and practical aspects of the current campaign against dusts causing silicosis. In Berlin, Dr. Bauer, the Reich's Labor Ministry's medical advisor, spoke on "Damages sustained in severe silicosis." The group visited the University-Institute for Occupational Diseases, the State Porcelain Works, the Siemens Plant (sandblast-polishers), and the Berlin industries having a silicosis risk (silica paint works and cosmetic and scouring powder manufacturers). Dr. Udluft, the geologist, talked on the minerals whose dusts cause silicosis and pointed out their occurrence in the terrain around them. Prof. Jötten, Government Research Laboratory for Industrial Diseases, Munster, reported his results on "Dust research upon experimental animals." At the Kaiser-Wilhelm Institute for Physiological Research in Dortmund, G. Lehmann demonstrated his work on the efficiency of the nose in dust filtration. At the Silicosis Symposium, in session at the Bochum mines, silicosis experts discussed the pathology and clinical course of silicosis and the miners' susceptibility to it in that region. In Düsseldorf Dr. Lochtkemper showed an X-ray series illustrating silicosis in its several phases and in different occupations. The ceramic industries were studied in Frankfurt-am-Main, where slipware porcelain, technical appliances, and dentures are made. Silicosis is found among the Elb stone-workers. Dr. Brandt, industrial physician of the vicinity, and Prof. Saupe at their clinic reported on silicosis and asbestosis in Saxony. Dr. Siegmund, Kiel, spoke on his research on colloidal silicic acid.

K.R.

Training of a chemical engineer. R. K. MURPHY. *Jour. Australian Chem. Inst.*, 3 [4] 109–25 (1936).—American, European, and Australian methods are compared.

H.H.S.

What to do after the flood. G. A. VAN BRUNT. *Factory Management & Maintenance*, 94 [4] 144–45, ad. p. 52 (1936).—Bearings should be emptied, silt cleaned out, and grease or oil removed with solvents. Motors and transformers should be dried out and insulation checked by resistance tests. Meters should be returned to the maker. Gears and transmission chains should be cleaned. Rubber and waterproof belts need only to be cleaned and the surface dried. Leather belts must be cleaned and then dried very slowly under a coating of belt dressing or oil. Foundations, floors, and roofs should be checked and repaired where needed. Illustrated. See *Ceram. Abs.*, 15 [1] 46 (1936).

J.L.G.

Why and how an engineer can help clay products plants. ERNEST W. KNAPP. *Brick Clay Rec.*, 88 [4] 147–48 (1936).—Many plant failures and inefficiencies are due to faulty design. The application of common sense, practical engineering skill to the remodeling and rebuilding of plants and equipment would help improve the quality of the ware and reduce costs now often exorbitant. K. cites personal remodeling of a drier to reduce costs and secure better operation. The advantages of properly operated updraft kilns are also cited.

E.J.V.

NEW JOURNAL

Annals of Science. (Quarterly.) Edited by D. MCKIE, HARCOURT BROWN, AND H. W. ROBINSON. Taylor & Francis, London. Price 6s 3d. quarterly, or £1 per annum, post free. Vol. 1, No. 1, Jan., 1936. Reviewed in *Discovery*, 17 [194] 58 (Feb., 1936).—This is a quarterly review of the history of science since the Renaissance.

H.H.S.

BOOKS

New Zealand Official Yearbook, 1936. Edited by J. W. BUTCHER. G. H. Loney, Govt. Printer, Wellington, N. Z. Price 7s 6d.—The book contains statistics of all industries. H.H.S.

Technical Data on Fuel. 4th. ed. H. M. SPIERS. Brit. Nat. Comm., World Power Conference, London, 1935. xvi + 358 pp. Price 12s 6d. Reviewed in *Chem. & Ind.*, **55** [18] 343–44 (1936).—This book is considered the standard English work of reference to technical data on the use of gaseous, liquid, and solid fuels. In addition to data on fuel, sections of considerable length and of fairly wide scope are devoted to refractories, measurement of heat and fluid flow, properties of air, steam, water, and certain gases, and the thermal characteristics and composition of those metals and alloys which are frequently used in the construction of apparatus and plant by the fuel technologist. A short bibliography and a list of appropriate British Standard Specifications and of publications which give standard analytic methods are also given. The compact form of the book and the interleaving of the text with blank pages to allow the user to add further relevant data make it a valuable volume for the desk or laboratory bench. See *Ceram. Abs.*, **11** [11] 588 (1932).

PATENTS

Electric condensers. STEATIT-MAGNESIA A.-G. Fr. 790,509, Nov. 22, 1935; *Chem. Abs.*, **30**, 3192 (1936). Ceramic materials containing TiO_2 are used for the establishment of electric circuits or condensers independent of the temperature. The ceramic materials used have a basis of Mg silicates or MgO.

Method of forming ceramic products. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 446,386, May 13, 1936 (July 13, 1934).

Method of making foundry sand. C. L. NORTON (Babcock & Wilcox Co.). U. S. 2,041,721, May 26, 1936 (Nov. 19, 1934).

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